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VOL. CXXXV.—No. 3504] LONDON: FRIDAY EVENING, FEBRUARY 23, 1923 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

In the High Court of Justice, 1922 C. No. 010.
Chancery Division,
Mr. Justice Astbury.
In the Matter of GEORGE CLARK Limited and Reduced
and
In the Matter of the COMPANIES (CONSOLIDATION) ACT 1908.

Notice is Hereby Given that a PETITION for CONFIRMING the REDUCTION of the CAPITAL of the above Company from £300,000 divided into 300,000 Shares of £1 each to £106,000 divided into 106,000 Shares of £1 each by returning to the Shareholders paid-up Capital in excess of the wants of the Company to the extent of £194,000 was on the 5th day of February 1923 presented to the High Court of Justice and is now pending. A list of the persons admitted by the Company to have been Creditors of the Company on the 5th day of February 1923 (the date fixed by the Order dated 16th February 1923) may be inspected at the Office of the Company at Southwick Engine Works at Southwick-on-Wear in the County of Durham or at the office of Messrs. Mann Longden and Mann at Somerford Buildings Sunderland in the said County of Durham or at the office of Messrs. Pothecary and Co. at 1 Gresham Buildings Basinghall Street in the City of London their Agents at any time during usual business hours on payment of the charge of one shilling.

Any person who claims to have been on the last-mentioned day and still to be a Creditor of the Company and who is not entered on the said List and claims to be so entered must on or before Thursday the 8th day of March 1923 send in his name and address and particulars of his claim and name and address of his Solicitor (if any) to the undersigned at Somerford Buildings Sunderland aforesaid or in default thereof he will be precluded from objecting to the proposed Reduction of Capital.

Dated this 16th day of February 1923.

MANN, LONGDEN and MANN,
P6983 Solicitors for the said Company.

In the High Court of Justice, 1922 S. 008.
Chancery Division,
Mr. Justice Astbury.
In the Matter of the SOUTH OF ENGLAND AGRICULTURAL MACHINERY COMPANY Limited
and
In the Matter of the COMPANIES (CONSOLIDATION) ACT 1908.

Notice is Hereby Given that a PETITION presented by the above-named Company to the High Court of Justice Chancery Division on the 7th December 1922 for CONFIRMING the REDUCTION of the CAPITAL of the above-named Company from £25,000 to £16,180—by cancelling Capital which has been lost or is unrepresented by available assets is directed to be heard before Mr. Justice Astbury at the Royal Courts of Justice, Strand, London on Friday the 9th day of March 1923. Any creditor desiring to oppose the making of an order for the reduction of the Capital of the said Company under the above Act may appear at the time of hearing by himself or his Counsel for that purpose. Such person is required to give two clear days' notice in writing of his intention to appear with the grounds of his objections to the undersigned the solicitors of the said Company.

A copy of the said petition will be furnished to any such person requiring the same by the undersigned on payment of the regulated charge for the same.

Dated the 20th day of February 1923.

PETER THOMAS and CLARK,
1, Bush-lane, Cannon-street, E.C. 4.
1620 Solicitors for the above-named Company.

PRINCIPAL OF THE ENGINEERING INSTITUTE, INSEIN, BURMA.

The Government of Burma

invite APPLICATIONS for the POST of PRINCIPAL of the ENGINEERING INSTITUTE, INSEIN. Three years' agreement in first instance. Salary at rate of Rs. 1500-50-1800-100-2300 per mensem inclusive, with free house. Free passage to Burma, with free return passage at end of agreement.

Candidates, not less than 35 years of age, should hold degree in civil engineering or similar qualification, and possess practical engineering experience, with five years' teaching experience in engineering subjects.

Full particulars may be obtained from the SECRETARY to the HIGH COMMISSIONER for INDIA, 42, Grosvenor-gardens, London, S.W. 1, to whom detailed applications should be submitted not later than 10th March, 1923.

February, 1923. 1580

East Indian Railway.

The Directors are prepared to receive up to Eleven o'clock a.m. on Wednesday, the 14th March, TENDERS for the SUPPLY of :—

(1) CORNISH and LANCASHIRE BOILERS.
(2) COVERED GOODS WAGONS.

Copies of the specifications can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.

G. E. LILLIE,
Secretary.

73-76, King William-street, London, E.C. 4.
21st February, 1923. 1626

The South Indian Railway Company,

Limited, are prepared to receive TENDERS for the SUPPLY of :—

STEEL WORK for BRIDGES for TINNEVELLY TIRUCHENDUR RAILWAY.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tenders for Steel Work for Bridges," must be left with the undersigned not later than Twelve Noon on Friday, the 16th March, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of the specification.

Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1.
20th February, 1923. 1627

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

The British Industries Fair.

Internal Combustion Heat Losses.

Some Mechanical Problems in the Rubber Industry.

Wireless Equipment for Aircraft.

Southern Railway—S.E. & C.—3 cylinder Locomotive.

Engineering Work at a Sanatorium.

Problems in High Speed Alternator Construction.

Oil Engine Nomenclature.

PUBLIC NOTICES

Corporation of Calcutta.

NOTICE TO CONTRACTORS.

TENDERS are INVITED for the SUPPLY, ERECTION and INSTALLATION of an AERIAL ROPEWAY for the removal of the city refuse from the site of the motor lorry platform at Chingrighatta to the Square Mile.

Tenders should be submitted in duplicate and should be enclosed in a sealed cover superscribed "Tenders for the Erection and Installation of an Aerial Ropeway," and should be addressed to the Deputy Chairman Corporation of Calcutta, Central Municipal Office, 5, Corporation-street, Calcutta, and must reach him on or before the 20th April, 1923, when they will be opened in the presence of such tenderers or their accredited representatives as may be present.

Tenders must remain open for acceptance for at least three months from the date of opening.

For further particulars, if required, apply to the Chief Engineer, Corporation of Calcutta.

One set of the specification in duplicate with copies of plans may be obtained gratis from Messrs. The Indian and Eastern Engineer, 50, Fenchurch-street, London, E.C. 3.

The Corporation do not bind themselves to accept the lowest or any Tender.

JAMES R. COATS, B.Sc., M. Inst. C.E.,
Chief Engineer.

Central Municipal Office,
31st January, 1923. 1578

Romford Rural District Council.

RIVERSIDE SEWERAGE.

CAST IRON PIPES.

The Council are prepared to consider TENDERS for about 185 TONS of 30in., 24in., and 18in. diameter CAST IRON SOCKET PIPES, required at the Outfall Works adjoining Rainham Creek, Essex.

Particulars may be obtained from Mr. William Fairley, M. Inst. C.E., Consulting Engineer, Parliament Mansions, Westminster, S.W.

Tenders to be lodged with the undersigned on or before Twelve o'clock Noon, Tuesday, 6th March, 1923, marked "Tender for Pipes."

The Council do not bind themselves to accept the lowest or any Tender.

T. W. A. GREENHALGH,
Clerk to the Council.

19th February, 1923.
South-street,
Romford, Essex. 1565

Romford Rural District Council.

RIVERSIDE SEWERAGE—RAINHAM SECTION.

The above Council are prepared to receive TENDERS for the CONSTRUCTION of about 600 YARDS of 24in., 727 YARDS of 21in., and 725 YARDS of 18in. diameter PIPE SEWER, including TIDAL CREEK and RAILWAY CROSSINGS, MANHOLES, FLUSHING TANK, and other incidental WORKS in the Parishes of Rainham and Hornchurch, Essex.

Drawings, specification and quantities can be inspected at the office of Mr. W. J. Grant, Surveyor to the Council, 16A, South-street, Romford; also at the office of Mr. William Fairley, Consulting Engineer, Parliament Mansions, Victoria-street, Westminster, S.W. 1.

A copy of the bill of quantities and form of Tender can be obtained on deposit of a crossed cheque for £3 3s., made payable to the Council, which deposit will be returned on receipt of a bona fide Tender.

Sealed Tenders must be delivered to the undersigned on or before Monday, March 12th, 1923.

The Council do not bind themselves to accept the lowest or any Tender.

T. W. A. GREENHALGH,
Clerk to the Council.

16A, South-street, Romford,
14th February, 1923. 1546

PUBLIC NOTICES

South Staffordshire Water-

WORKS COMPANY.

FRESTWOOD BOREHOLES.

CONTRACT NO. 1.

TO BOREHOLE SINKERS.

The Chairman and Directors are prepared to receive TENDERS for SINKING LARGE BOREHOLES on the site of the Prestwood Pumping Station at Stourton, near Stourbridge, in the County of Stafford.

Copies of conditions of contract, specification, with form of Tender and schedule of quantities, may be obtained from the undersigned.

Sealed Tenders, addressed to me and endorsed "Tender for Boreholes," must be delivered not later than Noon, Thursday, the 15th March.

The Chairman and Directors do not bind themselves to accept the lowest or any Tender.

FRED. J. DIXON, M. Inst. C.E.,
Engineer.

Engineer's Office,
20A, Paradise-street, Birmingham,
February, 1923. 1615

Borough of Richmond (Surrey).

SALE OF STEAM PLANT.

The Council offer FOR SALE by TENDER TWO COMPOUND CONDENSING BEAM ENGINES; H.P. cylinders, 18½in. diameter, 37in. stroke; L.P. cylinder, 30in. diameter, 54in. stroke; revs., 34 per minute; fly-wheels, 16ft. in diameter; steam pressure, 80 lb. per square inch.

The plant will be sold as it stands.

It is anticipated that the first set will be available for removal by May and the second set by August, 1923.

Full particulars and forms of Tender can be obtained from Mr. H. Will. Apted, Assoc. M. Inst. C.E., Water Engineer, Waterworks, Richmond, Surrey.

Tenders must be addressed to the undersigned, endorsed "Tenders for Beam Engines," so as to be received by him not later than March 6th, 1923.

The Council do not undertake to accept the highest or any Tender.

HENRY SAGAR,
Town Clerk.

Town Hall,
Richmond (Surrey),
February, 1923. 1519

County Borough of Halifax.

ELECTRICITY DEPARTMENT.

The Halifax Corporation have VACANCIES for the following POSITIONS :—

CHIEF ASSISTANT.
STATION SUPERINTENDENT.
MAINS SUPERINTENDENT.
ASSISTANT MAINS SUPERINTENDENT.
METER TEST ROOM SUPERINTENDENT.
CHARGE ENGINEERS.

Applications, stating qualifications and salary required, to be sent to the undersigned not later than Ten o'clock a.m. on Monday next, the 26th instant.

By Order,
PERCY SAUNDERS,
Town Clerk.

Town Hall, Halifax,
20th February, 1923. 1613

Richmond (Surrey) Corporation

WATERWORKS.

REQUIRED IMMEDIATELY, TEMPORARY ASSISTANT; good draughtsman, experience in Pumping Machinery Lay-out and Foundations; practical experience essential; period three months. Salary £5 5s. per week.—Apply, giving age, experience, &c., to the WATER ENGINEER, Waterworks, Richmond, Surrey. 1635

SITUATIONS OPEN

WANTED, CIVIL ENGINEER, as Assistant for Maintenance of Small Railway abroad. Knowledge of Spanish most desirable.—Write, giving full details of experience, to "C.E.," c/o Street's, 30, Cornhill, E.C. 3. 1621 A

A LONDON FIRM of ENGINEERS Has a VACANCY for a competent DRAUGHTSMAN, well accustomed to Bridge Work, Roofing, &c. State age, experience, and salary required.—Address, P6956, The Engineer Office. P6956 A

BUYER WANTED, to Undertake the Entire Management of Purchasing Department and Deliveries of Materials at large Engineering Works. Applicants to state age, salary expected, and date at liberty, together with full details of buying experience.—Address, P6993, The Engineer Office. P6993 A

EXPERIENCED TRAVELLER REQUIRED for London Firm manufacturing boilers, welded and riveted tanks, jacket pans, buoys, tar stills, &c., also repairs to boilers, &c., to follow up quotations and get new business. State full particulars and salary required.—Address, 1611, The Engineer Office. 1611 A

LARGE FIRM of Electrical Manufacturers REQUIRE CHIEF ENGINEER for Switchgear Department. Must be thoroughly conversant with all Types of Switchgear, particularly A.C. and D.C. Starters and Control Gear.—Address, stating age, full particulars of qualifications and salary required, P6912, The Engineer Office. P6912 A

SMALL IRONFOUNDRY in Birmingham District has VACANCY for energetic MANAGER to Take Charge of Manufacture and Sales of General Engineering and Colliery Castings under board of directors. State age, experience, and salary required.—Address, P6966, The Engineer Office. P6966 A

TEST ROOM.—ASSISTANT MANAGER REQUIRED for Test Room of Large Electrical Manufacturing Company. Must be fully acquainted with the Testing, Inspecting and Adjusting of Large D.C. and A.C. Motors and Generators, also Turbo-generators of larger sizes. Only people with over six years' experience in test room considered.—Address, giving full particulars of past services, education, and salary expected, 1534, The Engineer Office. 1534 A

WORKS MANAGER.—APPLICANTS for Position advertised under Box No. 1365 are thanked for their replies and are informed that the VACANCY has now been FILLED. 1596 A

WATERWORKS ENGINEER'S ASSISTANT REQUIRED temporarily. Public waterworks experience essential; good Surveyor and Leveller.—Address, stating salary required, qualifications, and age, 1523, The Engineer Office. 1523 A

WORKS MANAGER WANTED for Small Factory, to turn out a number of patented articles with a ready sale; investment of £500 necessary, secured by debenture. Salary and percentage of profits from £300 per annum.—Address, 1609, The Engineer Office. 1609 A

YOUNG SALES ENGINEER REQD., Calcutta; exp. Railways, Rolling Stock, Pumps, &c., General Mechanical Work and Sales; age 24/26, single, £400 p.a.—Apply, LAURIE and CO., Employment Specialists, 2B, Basinghall-street, E.C. 2. 2s. 6d. preliminary fee. P6979 A

WANTED, DRAUGHTSMAN, Fully Qualified, Used to Constructional Work, Headgears, and Screening Plants. Only first-class men need apply.—State full particulars and salary required by letter to GOODALL, CLAYTON and CO., Ltd., Hunslet, Leeds. 1630 A

WANTED, DRAUGHTSMAN, with Experience in Colliery Screening Plant, Structural Work, &c. State experience, age, whether married or single, wages required, and when at liberty.—Address, 1628, The Engineer Office. 1628 A

WANTED, DRAUGHTSMAN, with Experience in Crushing Machinery, Elevators, Conveyors, and Cement Plant. State experience, age, whether married or single, wages required, and when at liberty.—Address, 1629, The Engineer Office. 1629 A

WANTED for Large Engineering Works, North of Spain, TWO SENIOR and TWO JUNIOR DRAUGHTSMEN, experienced in Design and Shop Ordering, Overhead Travelling Cranes and Jib Cranes; conveyor experience an advantage. Good prospects for suitable men; no quitters need apply. Salary for senior men £7 per week and upwards, dependent upon experience.—Address, 1592, The Engineer Office. 1592 A

WANTED IMMEDIATELY in London, DRAUGHTSMAN with experience in Steam Power Station Design and Pipe Work Lay-outs. Electrical experience also desirable.—Address, stating age, experience, salary expected, and when free, P6961, The Engineer Office. P6961 A

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SITUATIONS OPEN (continued)

WANTED, Temporarily, MECHANICAL DRAUGHTSMAN, experienced in Waterworks Ironwork and Bridge Design. Give full particulars of experience, age, and salary required.—Address, 1522, The Engineer Office. 1522 A

CHIEF DRAUGHTSMAN WANTED IMMEDIATELY, Centrifugal Pump Department; detail pump experience unnecessary if of wide general engineering experience, including foundry and workshop practice. Must be able to control men, direct mechanical design and handle correspondence. State salary required. Only men of highest qualifications will be considered.—Reply by letter in own handwriting, MATHER and PLATT, Ltd., Employment Department, Park Works, Manchester. 1588 A

DRAUGHTSMAN REQUIRED Who Can Combine a knowledge of the arrangement of Flour Milling Machinery with a sound practical experience of Building Design. Give full particulars of experience, stating age and wages required, 1595, The Engineer Office. 1595 A

DRAUGHTSMAN WANTED, North London; Preferably one conversant with Locomotive and Carriage Design.—Address, giving full particulars, 1623, The Engineer Office. 1623 A

DRAUGHTSMEN WANTED, Thoroughly Experienced in the design of:—
(a) Heavy Steel Bridges, both fixed and movable.
(b) Steel Caissons and Gates for Dock Entrances.
(c) General Dock and Railway Construction Work.
Only men of the highest abilities in design and detailing of such work need apply.
Applications, stating age, salary required, and full particulars of training and experience and when at liberty, to be addressed to Box No. 2458, Willing's, 30, King-street, Covent Garden, W.C. 2. 1593 A

ENGINEERING DRAUGHTSMEN REQUIRED; Aircraft experience preferred, but not essential. Reply, stating age, experience, and salary required, to Box 297, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, E.C. 4. 1604 A

GOOD BRIDGE and CONSTRUCTIONAL DRAUGHTSMAN REQUIRED; must be good designer.—Apply by letter, enclosing copies of recent testimonials and stating wages required, to JOHN BUTLER and CO., Ltd., Stanningley Ironworks, near Leeds. 1616 A

HEATING ENGINEER DRAUGHTSMAN, for Designing and estimating Warming Systems employing water and steam.—Write, stating age, experience, salary, to HENRY HOPE and SONS, Ltd., 59, Berners-street, London, W. 1. 1582 A

LOCOMOTIVE DRAUGHTSMEN REQUIRED in Newcastle-on-Tyne. State experience, age, salary required. Only first-class men need apply.—Address, 1583, The Engineer Office. 1583 A

TEMPORARY DRAUGHTSMAN WANTED for the Design of small Mechanical and Electrical Apparatus.—Address, stating full particulars, 1612, The Engineer Office. 1612 A

WANTED for Large Works in Calcutta, FOREMAN BLACKSMITH, who has served his time in a shipyard. Unmarried man, age 24-26 years. Five years' agreement.—Send full particulars of experience and copies of any testimonials to Z. O. 756, care Deacon's, Leadenhall-street, London. 1602 A

ENGINEER WORKING FOREMAN WANTED for provincial shop; about 20 hands. State age, experience, salary, when commence. Copies references only (not returnable).—Address, 1586, The Engineer Office. 1586 A

FOREMAN for GUN-METAL FOUNDRY; Young, energetic, capable of making high-class Hydraulic Castings and experienced with Moulding Machinery and up-to-date methods.—Address, 1453, The Engineer Office. 1453 A

REQUIRED by Well-known Firm (London District), first-class MAN for Tool Inspection Work. Applicants must have had up-to-date experience on Tools, Gauges and Fixtures used for the production of small repetition parts in large quantities.—Address letters, P6969, The Engineer Office, stating experience, age and wages required. P6969 A

SITUATIONS WANTED

WANTED, POSITION of ENGINEERING SHOP MANAGER; good organiser, with good testimonials, having held similar position with prominent engineering firms.—Address, P6824, The Engineer Office. P6824 B

WANTED, RE-ENGAGEMENT as MAINTENANCE ENGINEER for factories or manage repair shops.—Address, P6992, The Engineer Office. P6992 B

A LONDON B.Sc. (Engineering), Aged 21, DESIRES POST as Assistant in Civil or Mechanical Engineer's Office; experience, not salary, chief consideration.—A. L. B., 21, Chardmore-road, N. 16. P6988 B

APPRENTICESHIP (Short) or SIT. REQD. in Office or Works by youth (17 yrs.); 3 yrs. technical train., 6 mths. improver; small wages if good prospects, refs.—M., 1, Finchley Villas, Finchley Park, London, N. 12. P6958 B

ASSISTANT, C.E. (22) SEEKS ENGAGEMENT similar capacity, or with Structural Engineers, London district; 2 years' technical and practical training, 1½ years works D.O., 3 years assistant, principally on calculation and design of steel work; familiar L.C.C. requirements, excellent refs.—Address, P6965, The Engineer Office. P6965 B

BUYER.—The MANAGER of a large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M., 613, c/o Deacon's, Leadenhall-street, E.C. 1625 B

CHIEF ENGINEER of Important Company DESIRES CHANGE. Minimum salary £1000.—Address, P6957, The Engineer Office. P6957 B

CIVIL ENGINEERING ASST. REQUIRES POSITION abroad; 23, single, energetic, capable; 8 years' all-round experience English railway.—Address, P6959, The Engineer Office. P6959 B

CONSTRUCTIONAL ENGINEER, Young, Energetic, shortly able to conclude agreement with leading steel work firm in London, DESIRES APPOINTMENT with established business where good personal connection and thorough knowledge in all branches of building construction would be of service.—Z. W. 801, care Deacon's, Leadenhall-street, E.C. 1603 B

CONSTRUCTIONAL STEEL WORK.—ENGINEER, A.C.G.I., now chief designer with leading firm, DESIRES similar POST or POST as CHIEF DRAUGHTSMAN in London or Midlands.—Address, P6970, The Engineer Office. P6970 B

ENGINEER (Age 23). Five Years' Apprenticeship fitting and machining, two years' marine experience, SEEKS POSITION, London.—Address, P6971, The Engineer Office. P6971 B

ENGINEER, A.M.I.M.E., A.M.I.E. (India), at present holding important appointment in India, with 20 years' mechanical and electrical engineering experience in England and India, REQUIRES ACTIVE PARTNERSHIP with firm of mechanical, electrical, or motor engineers engaged in the manufacture of accessories, &c. Can invest about £2000. Manchester or London district preferred.—Address, P6937, The Engineer Office. P6937 B

ENGINEER (30), A.M.I.N.A., M.I. Mar. E., Experienced shop, D.O., commercial, and management, steam and I.C., at present responsible position small shipyard, DESIRES CHANGE with prospects.—Address, P6967, The Engineer Office. P6967 B

ENGINEER (23½), B.Sc. (Lond.), 2 Yrs. Vickers' apprenticeship, incl. D.O., 1 year estimating and production, REQUIRES CHANGE, junior position works staff preferred.—Address, P6991, The Engineer Office. P6991 B

ENGINEER, Mechanical, Experience as Manager of general engineering works, foundry, boilermaking, accustomed to control of office, staff and shops, DESIRES similar ENGAGEMENT; age 42.—Address, P6968, The Engineer Office. P6968 B

ENGINEER REQUIRES Permanent, Progressive APPOINTMENT; public school man, 3 years University, 5 years apprenticeship, 12 years' practical, technical and commercial experience in mechanical, constructional and public works at home and abroad; previous engagements include clerk of works, chief draughtsman, chief engineer, London office manager.—F., 2, Summerlands-crescent, Acton, W. 3. P6980 B

ENGINEER, Practical Experience 14 Years, Commercial over 15 years in his present post as manager of London business of large steel works making high-class products and materials, SEEKS similar APPOINTMENT, not necessarily similar productions. Fully conversant with contractors' and railway business, home, overseas and foreign, also export business in all its aspects.—Address, P6975, The Engineer Office. P6975 B

EXTENSIONS ENGINEER, Thoroughly Experienced in electrical, structural, and general engineering (works and D.O.), good knowledge of building and ferro-concrete; competent to control labour, energetic; excellent references.—Address, P6984, The Engineer Office. P6984 B

HEATING ENGINEER, Theory and Pract., SEEKS POST as ASST. WORKS MANAGER; seven years' apprenticeship, previous experience, references.—Address, P6930, The Engineer Office. P6930 B

REINFORCED CONCRETE ENGINEER, with Continental and American practical and theoretical experience, SEEKS POST.—Address, P6986, The Engineer Office. P6986 B

REQUIRED, an APPOINTMENT as REPRESENTATIVE or other capacity in engineering coy. Advertiser, well educated, young, energetic and skilful, with thorough practical training by celebrated engineers.—Address, P6996, The Engineer Office. P6996 B

SALES ENGINEER, Well Known to Mechanical and Electrical trades in London, DESIRES to Re-PRESENT an Old-established Manufacturer; can commence actively by March.—Address, P6976, The Engineer Office. P6976 B

STRUCTURAL ENGINEER, Highest Engineering degrees and several years' practical experience, SEEKS POST.—Address, P6985, The Engineer Office. P6985 B

TECHNICALLY TRAINED ENGINEER (26) REQUIRES POST with good firm of consulting or other engineers; 7 yrs. shop, D.O., and college, 3 yrs. mining, 4 yrs. commercial experience; specialised in fuel economy and friction reduction.—Address, P6974, The Engineer Office. P6974 B

WORKS MANAGER, Excellent Long Service record with general engineers and ironfounders, SEEKS SIMILAR POSITION; well-educated man, with sound works and D.O. experience, good organiser, successful control of labour; moderate salary.—Address, P6864, The Engineer Office. P6864 B

YOUNG CIVIL ENGINEER (23), B.Sc. (1st Class Hons.), REQUIRES WORK, home or abroad. Nominal salary for beginning; single, ex-Service.—Address, P6960, The Engineer Office. P6960 B

3RD YEAR MECH. and ELEC. ENGINEERING STUDENT, Glasgow Univ., prac. exp., good draughtsman, speaks French, WANTS TEMP. SITUATION, April to Aug. inclusive.—Address, P6982, The Engineer Office. P6982 B

DRAUGHTSMAN or ASSIST. MANAGER for Rolling stock, mechanical electrical or structural and general engine design and details; 5 yrs. works and 10 yrs. D.O.; age 31.—Address, P6981, The Engineer Office. P6981 B

ENGINEERING DRAUGHTSMAN (34) REQUIRES E JOB; 18 years' shops and D.O. experience on mechanical filtration, refrigeration, contractors and general machinery.—Address, P6944, The Engineer Office. P6944 B

JIG and TOOL DRAUGHTSMAN (21) SEEKS POST; 4 years' technical training and 4 years' shop and D.O. experience; highest references.—Address, SHELTON, 102, Norwood-road, S.E. 27. P6994 B

FOUNDRY FOREMAN REQUIRES SIT; Age 38; iron and brass, gen. eng. and jobbing, loam, plate and mach. State wages offered.—Address, P6983, The Engineer Office. P6983 B

STOREKEEPER (Experienced) SEEKS an ENGAGEMENT (any capacity); good organiser, capable of controlling all stores depts.—Address, P6967, The Engineer Office. P6967 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.,
46, Watling Street, London, E.C. 4.
Established seventy years.

GENTLEMAN, with First-class Technical and Practical training in mechanical and marine engineering, having special experience with turbine machinery, water-tube boilers and internal combustion engines, DESIRES to get in TOUCH with an established FIRM of CONSULTING ENGINEERS with a view to PARTNERSHIP.—Address, P6972, The Engineer Office. P6972 C

PARTNERSHIPS, DIRECTORSHIPS.—We Have a large number of men, fully qualified and experienced, who have £10,000, £8000, £7000, £5000, £3000, £2000 to invest. We want well-established businesses able to give immediate incomes. We print a paper, "The Business Broker," free, to bring investors and investments together.—OFFICERS' PARTNERSHIP GUARDIAN, Ltd., 49, Dover-street, W. 1. For all educated men. Call. 1594 C

AGENCIES

A FIRM of ENGINEERS and NAVAL ARCHITECTS on N. East Coast are OPEN to REPRESENTATIONS in either Land or Marine Work. Connection with engineers and consultants, shipyards, collieries, and factories.—Address, P6990, The Engineer Office. P6990 D

A WELL-KNOWN MECHANICAL ENGINEER, Dutchman, having an established connection amongst the leading factories and works in Holland, is OPEN to REPRESENT FIRMS of good standing, having suitable specialities. Knows English trade.—Letters under S. O. K., to Nijgh and Van Ditmar's Adv. Office, Amsterdam. P6977 D

OLD-ESTABLISHED FIRM, Manufacturing Well-known Marine Engine Auxiliaries, REQUIRES AGENT for Glasgow and Scottish districts. Only firms already having agencies connected with marine engineering need apply.—Address, 1371, The Engineer Office. 1371 D

TO MANUFACTURERS AND MERCHANTS.—ROLLED STEEL MATERIAL.—GENTLEMAN DESIRES PART-TIME EMPLOYMENT, London, following inquiries, seeking business; would travel; inspection, D.O., works, continental experiences.—Address, P6979, The Engineer Office. P6979 D

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Internal Combustion Heat Losses and Specific Heat of Working Fluid.

By WM. J. WALKER, Ph.D., University College, Dundee.

THE complex nature of the phenomena which occur during the explosion and combustion of gases in a constant or variable-volume vessel renders the problem of separation of each constituent factor concerned in such combustion a baffling and well-nigh impossible one. So far as its engineering aspect is concerned, however, "it is possible, . . . by explosion experiments to deduce values of the *apparent* or *effective* specific heats, which, in so far as they approximate to the conditions actually existing in the gas engine, may be of greater practical utility than the true specific heats would be if they could be independently determined."[1] It is from such a point of view that the problem is considered here, the article being written principally with the object of drawing attention to one feature of explosion and gas engine experiments which does not appear hitherto to have received much, if any, consideration. The feature in question relates to the extent of transparency of the combustion products of a normal mixture to its own radiated heat.

The principal constituents, the specific heats of which are of most importance, are air, CO_2, and H_2O, and the methods of measurement which have been chiefly adopted are three.

(1) Constant pressure method.
(2) Constant volume or explosion vessel tests.
(3) Both pressure and volume variable.

The classic results in these three methods are those due to Regnault, Mallard and Le Chatelier, and Clerk respectively. More recently results by the second method due to Pier and Bjerrum in Germany and to Professor David in this country have been published, and also by the writer using the third method not on the same lines as Clerk's famous zig-zag experiments, but on lines the theory of which is based both on the pressure-volume relationship during adiabatic expansion and compression and also on engine thermal efficiency results.[2]

Professor David, in his explosion experiments,[3] determined the radiation losses by bolometric measurements, and the conduction losses by means of a grid of highly polished silver sheet mounted upon a backing of linoleum and placed upon one of the end covers of the explosion vessel, the rate of variation in electrical resistance of the grid being a measure of the rate of its heat absorption by conduction. The results of the experiments conform to expectations only in the case of the radiation losses which were found to be proportional to the fourth power of the temperature and so were in accordance with Stefan's law of radiation. In the case of the conduction losses the somewhat astonishing result appeared that they also were approximately proportional to T^4 over gas temperatures ranging from 2000 deg. Cent. to 1750 deg. Cent. absolute. Down to 1500 deg. Cent. absolute, the losses were more nearly proportional to T^3, and below that the proportionality followed the T^2 relation. No explanation appears to have been put forward to account for this apparent departure from the usual linear temperature law for heat conduction. The writer's view is that the conduction loss, as measured, was, in all likelihood, largely a radiation loss. His reason for taking this view is that there is at least some probability that the low absorption value of the silver grid for radiated heat is not maintained at the high temperatures. It may be that experimental evidence exists for or against this tentative explanation, but the writer is not aware of any. Whatever the reason for this unusual relationship between temperature and apparent heat conduction loss, however, it seems highly probable that it will be ultimately traceable to a radiation effect of some kind. The fact that the temperature index diminishes so rapidly with temperature lends itself to this view.

It is frequently stated that the gaseous medium of closed-vessel tests is highly transparent to its own radiation. The writer questions this assumption for two main reasons. First, that the diathermancy of the gases will decrease with increasing density. This explains the apparently lower values of specific heat at the higher densities. The reason for the relatively high explosion pressures attained by Professor Petavel[4] in his experiments thus lies in the diminished radiation losses at high densities. In the case of any gases consisting of particles of H_2O, the interception of radiated heat by such particles must, at least, be appreciable. Indeed, the fact that the specific heats at constant pressure and constant volume may be written

$$\left(\frac{d\,K_p}{d\,P}\right)_T = -\,T\left(\frac{d^2\,V}{d\,T^2}\right)_p$$

and

$$\left(\frac{d\,K_v}{d\,V}\right)_T = T\left(\frac{d^2\,P}{d\,T^2}\right)_v$$

respectively, is a strong argument against any variation of specific heat with density at high temperatures, since the departure from the usual gas law at such temperatures can scarcely be to the extent required to make the argument valid.

The second reason for non-belief in the high transparency of the gases to their own radiated heat is based on the conviction that, during the first half-second of the explosion, at least, heat losses in closed vessel tests are almost wholly radiation losses. This conviction is upheld principally by the fact that test results on explosion vessels of different dimensions can be thereby reconciled. For high transparency, total heat losses on this view, should, in explosion-vessel tests, be proportional to P. Actually they are not so proportional. Various figures put forward by different experimenters, for the value of the index n in the relation

$$\text{Total heat losses} \propto l^n$$

all agree that n is less than 3. If heat losses in such closed-vessel tests are practically all radiation loss at the outset, as the writer contends, high transparency would give the P^3 law. The only possible argument against this is that heat conduction losses will be proportional to l^2, and so, in effect, will reduce the index n to some value between 3 and 2. It will be shown here, however, both from experimental and analytical evidence that this reduction in the value of n is explained by relatively low transparency of gases to radiated heat, while holding at the same time that the initial conduction loss in closed-vessel tests is practically negligible.

Taking analytical evidence first, assume Fig. 1 to represent the cross section of a spherical explosion vessel. If the diathermancy of the gases is something less than unity, then there will be a spherical region in the centre, the radiated heat of which shall never reach the walls as such. For low diathermancy values this spherical region will be relatively large. From Fig. 1, therefore, the radiated heat reaching the walls will be proportional to the volume of the spherical shell of gases of effective radiative power contained between the radii r_1 and r_0. For any size of vessel it may be assumed fairly safely that, under otherwise similar conditions, the value of $r_1 - r_0$ will be constant. Total heat loss by radiation should therefore be proportional to

$$h \propto r_1^3 - r_0^3$$
$$\propto r_1^3 - (r_1 - c)^3$$
$$\propto 3\,r_1^2\,c - 3\,r_1\,c^2 + c^3$$

$$\therefore \text{Heat loss per unit area} \propto A - \frac{B}{r_1} + \frac{K}{r_1^2}$$

where A, B, and K are constants.

The full line of Fig 2 indicates graphically the consequences of such a theory down to the limiting condition that $r_1 = c$, and bears out generally accepted results. The dotted line to the left of the full line curve is intended to illustrate the fact that the P^3 law should hold up to the point when r_1 becomes equal to c. There does not appear to exist, however, a wide enough range of explosion tests on vessels of different dimensions, which might negative, or otherwise, the reasoning from which the curve has been deduced, although it is corroborated to some extent by Callendar's flame experiments[5] for which it was shown that up to flame diameters of 3 cm., the radiation loss was found to be proportional to volume. Reliable tests are still required, however, on spherical explosion vessels of small radii, and also on long narrow cylindrical vessels.

It is instructive at this point to turn to a survey of engine tests for comparison with explosion-vessel tests. Here the effect of initial turbulence enters at once to modify results. In a series of gas engine tests by Professor A. H. Gibson and the writer[6], the result was demonstrated that the *effective* conductivity of the gases was proportional to the speed of the engine. In explosion-vessel tests, turbulence before ignition does not exist, and it appears unlikely that ignition itself produces that scrubbing action of gases on the surfaces of the vessel which is the determining factor in heat loss from gases to a metal wall. Thus, while the proportion of radiated heat will remain practically constant under given conditions of mixture strength and compression ratio, the conducted heat will increase directly with speed. This must not, of course, be read to imply that an engine of 2000 revolutions per minute will have, in the same period, ten times the proportion of conducted heat as would pass through the walls of an engine running at 200 revolutions per minute. Everything will depend in each case upon the design of the induction system and the degree of turbulence effected thereby. In the same engine, however, without alteration of valve settings or throttle opening, it may be said that the amount of heat lost primarily by conduction is proportional to some direct function of the engine speed. The jacket water heat, however, it should be observed, is the sum of the radiated and conducted heat.

In engine tests it has been found also that, in general, the heat losses per square foot of cooling surface, during explosion and expansion, are approximately proportional to l^n where n has some value between .5 and .6. For total heat loss proportional to volume, n should here be equal to unity, but the departure from this proportionality is not due wholly to the same cause as in the case of explosion-vessel tests. In the engine tests, effective conductivity of gases enters also to diminish the value of n to the above figure. It is probably for this reason that, in engines of aircraft dimensions and speed, this relationship, namely, that heat loss per unit area is proportional to $l^{.5}$ or $l^{.6}$ still holds. It is a moot point whether it would do so for small spherical or narrow cylindrical explosion vessels of the same order of dimensions, the initial effective conductivity of the gases under the static conditions holding in such vessels being, according to the present view, practically nil in relation to radiative power.

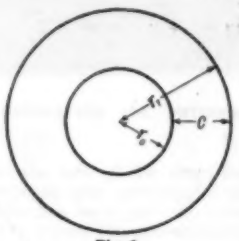


Fig. 1

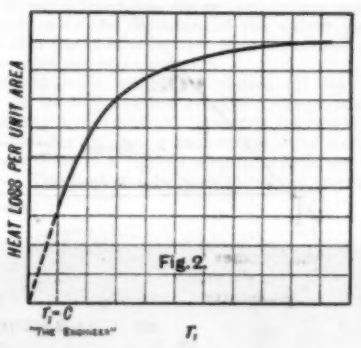


Fig. 2.

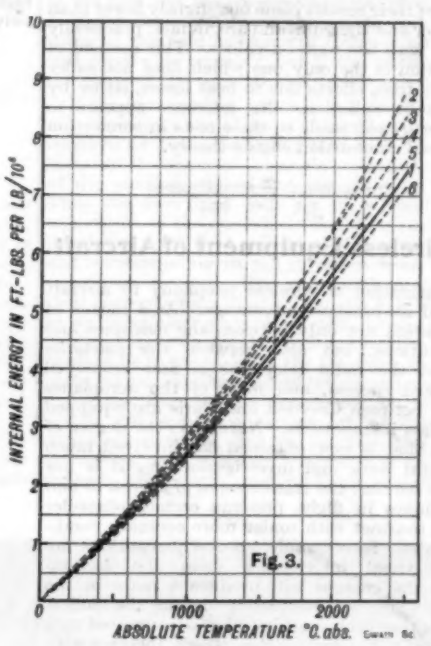


Fig. 3.

As a result of the aforementioned experiments by the writer, supplemented by oil engine test results, the derived values of the specific heats at constant pressure and constant volume are

$K_p = 316 + .0623\,T$ foot-pounds per pound per deg. Cent.

$K_v = 220 + .0623\,T$ foot-pounds per pound per deg. Cent.

The internal energy line based on these specific heat values is shown by the full line in Fig. 3. The remaining lines are derived from various authorities, as indicated below :—

Curve 2.—$K_v = 212.8 + .105\,T$ [Wimperis from B.A. curve].
Curve 3.—$K_v = 245 + .0714\,T$ [Sir Dugald Clerk].
Curve 4.—$K_v = 233 + .07\,T$ [Professor David].
Curve 5.—$K_v = 220 + .0693\,T$ [Pier and Bjerrum].
Curve 6.—$K_v = 217 + .0575\,T$ [Dr. Langen].

The large discrepancies between these different values are somewhat disconcerting. The writer's values are slightly higher than those of Langen, one of the German authorities, and slightly less than those

[1] Prof. Callendar. See p. 382, "The Gas, Petrol, and Oil Engine," Vol. I. Clerk.
[2] *Proc. I.M.E.*, Dec., 1920, pp. 1307-1308.
[3] *Phil. Trans.* A. Vol. CCXI. *Proc. Roy. Soc.*, Vol. XCVIII. *Phil. Mag.*, May and Sept., 1920.
[4] *Phil. Mag.* and *Roy. Soc. Proc.*, 1902.
[5] *Proc. R.S.A.*, LXXVII, p. 400. April, 1906.
[6] *I.M.E. Proc.*, May, 1916.

of Pier and Bjerrum, but are definitely less than the first three.

In a series of gas engine tests using different compression ratios,[7] the writer calculated the efficiencies from the formula

$$\eta = \left\{1 - \frac{1}{r^{m-1}}\right\} \left\{1 - \frac{\lambda T_c}{2}(a+1)\right\} \quad . \quad (1)$$

where $m = \frac{A}{B}$ as derived from the formulæ $K_p = A + S T$

and $\lambda = \frac{S}{B}$ $K_v = B + S T$

T_c being temperature at the beginning of compression and a being the explosion ratio

$$= \frac{\text{Pressure at end of explosion}}{\text{Pressure at end of compression}}$$

Taking $m = \frac{316}{220} = 1.435$ and $\lambda = \frac{.0623}{220} = .000283$

as derived from the specific heat values of Curve 1, the relative efficiencies were found to increase progressively, at full load, from 88 per cent. at a 5.17 compression ratio to 94 per cent. at a compression ratio of 6.62. Since the close approximation of formula (1) to variable specific heat theory is not in question, it does not appear possible that λ can be much higher than the above value. Otherwise, little loss in efficiency can be accounted for by departure from the ideal constant volume cycle. The reason for the close approximation of the actual cycle efficiency to the ideal efficiency, at the higher compression ratios, is, probably, the closer conformity of the actual cycle to the ideal cycle at the higher ratios.

More recently Professor Dixon and others have measured the specific heats of CO_2, N_2, and air[8] by measurements of sound velocity in the medium, and in each case their results come out slightly lower than those of Pier and Bjerrum, and are, in fact, practically coincident with the writer's values. This method of determination is the only one which does not suffer appreciably from effects due to heat losses, either by conduction or radiation. No reference appears to have hitherto been made to these tests in connection with internal combustion engine theory.

The Wireless Equipment of Aircraft.

THE application of wireless telephony to aircraft has proved an immense advantage. As a means of communication not only between the machines and ground stations, but also between the machines themselves, the radio telephone is now employed with marked success, and most of the aeroplanes which ply between Croydon and Paris are equipped with wireless installations. Naturally, the degree of perfection that is now obtained has involved much experimental work and investigation, for it is not difficult to see that the transmission of speech to and from machines in flight presents certain obstacles which are not met with under more ordinary conditions. Unless, for example, special precautions are taken, electrical interference from the ignition system of the engines will produce a noise in the telephones which will completely obscure the loudest signals, because each sparking plug is connected to a fair length of high-tension cable, which, together with the spark gap, forms a low-power transmitter, which radiates short waves of a highly damped nature. Engine and wind noises have also proved an obstacle to the transmission of articulate speech. But the fact that the Croydon wireless aerodrome station has been in successful operation for a considerable time, and that other similar stations are also at work, shows that these and other difficulties have been overcome. At Croydon there are two wireless stations, one for direction finding and the other for radio-telephonic communication with the aircraft. The object of the direction-finding station is, of course, to take bearings on aircraft whilst in flight, and these bearings are transmitted to the machines by means of wireless telephony. The arrangement of the direction-finding aerial is shown in Fig. 1, whilst Fig. 2 shows the transmitting aerial, Fig. 3 the low-tension switchboard and motor generators, Fig. 4 the transmitting apparatus, and Fig. 5 a standard Marconi direction finder and receiver. On the right of the latter picture a wave meter is to be seen, and just in front of it is a telegraph key.

The Marconi aircraft 1½-kilowatt ground stations are designed to enable a subscriber on a land line telephone exchange to communicate with a machine in flight, when the station then acts as a relay. Furthermore, by means of a direction finder the bearing of any machine in flight can be obtained, and use may also be made of the directional properties of the receiver to eliminate interference from other directions. The equipment is designed to transmit on a normal aircraft wave length of 900 m., but the equipments can, of course, be designed to work on other wave lengths if desired. Continuous-wave and interrupted continuous-wave telegraphy may also be carried out. The station is therefore well suited to serve as a large control station at a terminal aerodrome, and is capable of effectively fulfilling all the requirements of aircraft communication. The maximum range of any wireless station naturally depends on many factors, but provided all aeroplanes are equipped with proper receiving apparatus, stations such as that at Croydon can transmit good and clear speech over a distance of 250 miles. At night, and particularly in cases where an earth screen is used instead of the usual buried earth connection, considerably greater ranges can be obtained.

The transmitter—see Figs. 3 and 4—consists of four main parts, the low-tension supply, the high-tension supply, the high-frequency circuits, and the control circuits. The low-tension supply is derived from a motor-driven alternator—see Fig. 3—the motor being, of course, designed to suit the supply available. The alternator generates 300-cycle alternating current at a pressure of 200 volts, and feeds the primaries of the power, and the valve lighting transformers. A switchboard fitted with variable chokes serves for controlling the alternating and direct-current supplies, and with the aid of a special switching system the two sections of the primary power transformer may be connected in series or parallel, so that the set can be worked within wide power limits. The filaments of the transmitting valves are heated by low-tension alternating current from the secondaries of the filament transformers, variable iron chokes being inserted in the primaries for regulating purposes. The high-tension supply is obtained by rectifying the high-voltage alternating current which is derived from the secondary of the power transformer. Two valves of the two-electrode type are used for this purpose, and the rectified current is first smoothed out by a system of iron-core chokes and condensers, and is finally conducted to the anodes of the oscillating and control valves. In the high-frequency circuits there is a single three-electrode valve together with a reaction coil, reaction condenser, grid leak, and grid condenser. The inductance to which the reaction coil is coupled and to which the plate of the oscillation valve is connected forms the aerial tuning inductance and constitutes an auto-coupled circuit or a separate winding providing an inductively coupled arrangement. In the latter case the lower end of the aerial inductance may be connected to an earth screen instead of to the usual plate buried in the earth. The earth screen is a system of wires supported at a height of 6ft. or 7ft. above the ground and extending the full length of the aerial. By the use of the earth screen the effective range of the transmitter is considerably increased. The aerial system shown in Fig. 2 is supported by a pair of 70ft. sectional steel masts, or, alternatively, by two self-supporting steel lattice work towers of the same height. Provision is made for three kinds of transmission, viz., speech, interrupted continuous waves, and continuous wave telegraphy. In order that the speech may be effectively impressed on the outgoing wave, three control valves are used in cascade, to amplify the current variations set up by the microphone under the influence of the voice.

There are two methods of impressing speech on the outgoing wave, one being known as the absorption or damping method, and the other the choke control method. In the latter case the control valve varies the high-tension supply to the anode of the oscillator through the sub-control valve, whilst absorption or damping control is effected by the same two valves acting on the aerial circuit, the amplitude of the outgoing waves in this case being varied in accordance with the conductivity of the control valves, which in turn is influenced by the voice. Interrupted continuous-wave telegraphy is carried out by cutting in and out the smoothing condenser in the high-tension supply circuit, thus varying the current supplied to the anode of the oscillating valve at double the frequency of the alternator, the whole system being under the control of a Morse key. Continuous-wave telegraphy is effected by means of a relay, which interrupts the grid and high-tension circuits of the oscillator valve simultaneously. When the key is at rest a low-frequency choke is inserted in series with the filaments, so that their brilliancy is constant during transmission. For the purpose of putting land line speech on the wireless circuit a voice amplifier may be provided. To render the system immune from electrical noises the transmitter is designed so that it may be controlled from a distant point, such as at the receiving room, underground cables connecting the transmitter to the control gear. Furthermore, in order to ensure safety for the operators and the apparatus, various ingenious devices are used.

An automatic starter with a delay action relay prevents the transmitter being switched on before the generator has attained full speed, and the action of opening the gates of the high-frequency unit automatically cuts off all the power and discharges the condensers.

The direction finder, which is installed in the ground direction-finding station, provides a means for accurately determining the plane of signals and the absolute direction of reception. The Marconi aperiodic aerial system and tight-coupled search coil is combined with a loose-coupled jigger. A high degree of radio frequency amplification is provided, and there is also a two-stage audio frequency amplifier or note magnifier. The instrument is sufficiently sensitive to enable it to be used for ordinary reception, and under favourable conditions aircraft signals may be picked up during the day at a distance of 300 miles. The directional properties are of considerable value in the presence of jamming, but under normal conditions and for "stand-by" all-round reception is preferable.

The change from directional to all-round reception is made by means of a switch, and the change is brought about instantaneously. The circuits are equally suitable for the reception of spark, tonic train, telephony or continuous-wave signals, but in the latter case a local oscillation generator must be included in the installation. The complete direction finder, which is illustrated in Fig. 5, consists of a strong teak case, containing eight components fitted in separate compartments. Each compartment is lined with copper, and is thus screened electrically from its neighbour. The components comprise the direction finder—Fig. 6—the aerial tuning condenser, the transformer panel—Fig. 7—the jigger condenser, the jigger panel—Fig. 8—the control panel, the amplifier unit, and the double-note magnifier—Fig. 9. Each unit is built up on an ebonite panel, corresponding in size to the top of its compartment, and electrical connection to each compartment is made by a row of small screw terminals covered by an ivorine plate. Any component can easily be removed for inspection and cleaning without disturbing the remainder of the gear and without breaking any soldered joints. By operating the wave-changing switches mounted on the instrument three ranges of wave length can be obtained: (*a*) 300–750 m.; (*b*) 700–2000 m.; and (*c*) 1800–4500 m. (approx.)

In the Marconi system of direction finding movement of the aerials is unnecessary, and they may therefore be of sufficient size to ensure highly efficient directional reception. A standard equipment is shown in Figs. 1 and 10, from which it will be seen that two triangular aerials are used, their centre lines being on the same vertical axis and their planes at right angles to each other. The central mast is 70ft. long, whilst the inclined limbs are 92ft. long, and the horizontal limbs 140ft. long. The latter are broken at the centre, and are led down to the instruments in the manner shown in Fig. 11. If the receiver be re-

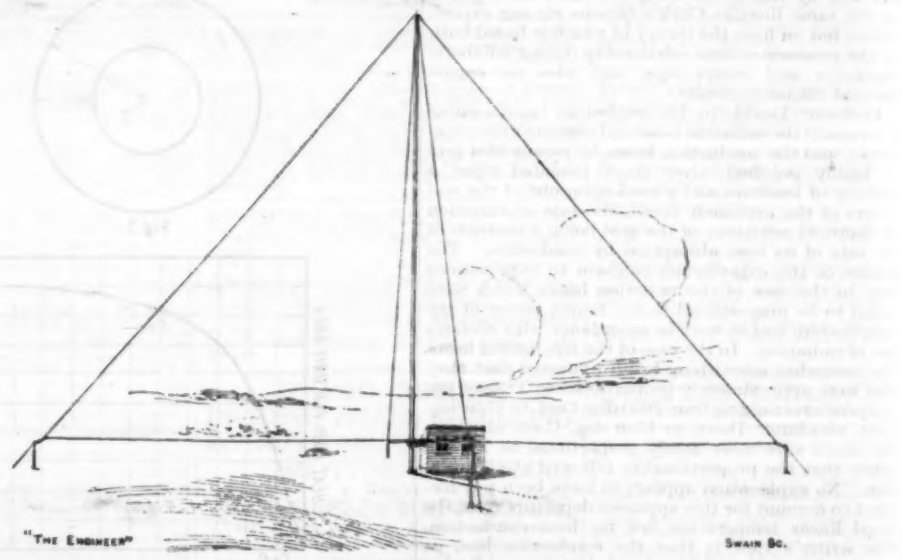


FIG. 1—ARRANGEMENT OF DIRECTION FINDING AERIAL

[7] *I.M.E. Proc.*, Dec., 1920, p. 1307.
[8] *Proc. Roy. Soc. A.*, Vol. 00, 1921.

quired to work in conjunction with a local transmitter (in which case the latter will be remotely controlled from the receiving house) arrangements are made so that during the transmission periods the direction-finding loops are connected together and earthed. This can usually be done directly through the send-receive switch, but when this is impracticable an earthing relay is required. The directional finding component, or "radio-goniometer"—shown in Figs. 6 and 12—is mounted on the lower panel at the extreme left of the instrument, and by connecting the four ends of the aerial loops to the terminals provided on the instrument box, each of the two field coils of this component is inserted in series with its

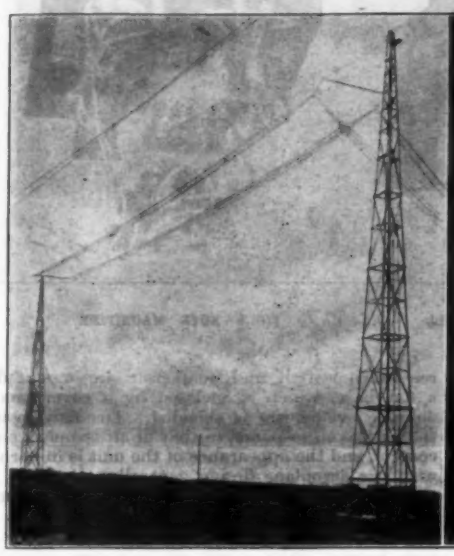


FIG. 2—TRANSMITTING AERIAL AND EARTH SCREEN

FIG. 3—MOTOR GENERATORS AND SWITCHBOARD

aerial system as shown in Fig. 10. The two field coils—see Fig. 12—are mounted at right angles and form two independent primaries of a high-frequency transformer with a rotable secondary or search coil. The aerial tuning condenser is of the variable capacity ebonite type. It is situated next to the direction-finding component on the lower panel, and is connected in parallel with the search coil for the short-wave range and in series for the ranges (*b*) and (*c*) referred to above. For the latter range extra capacity is provided in the form of block condensers, which are brought into circuit by means of a three-point switch which is mounted above the main condenser.

The transformer panel—shown in Fig. 7—consists of three air core transformer elements for the three ranges and the corresponding "sense" resistances, together with the three-way stand-by, sense and direction-finding switch and wave-changing switch. The particular transformer in use determines the wave range obtainable, and is selected by means of the wave-changing switch. On the right of the transformer panel is a second variable capacity air condenser for tuning the amplifier circuit, the adjustment for the various wave lengths being given on a chart supplied with the instrument.

The jigger panel—shown in Fig. 8—occupies a position on the extreme right of the instrument below the note magnifier, and it comprises three jigger windings, the jigger coupling coil, the oscillator coupling coil, and a three-position wave-changing switch. The jigger coupling coil varies the coupling of the aerial circuit to the secondary windings, whilst the oscillator coupling coil provides for reception by the beat method. The amplifying detector—shown in Fig. 5—is mounted in the centre of the upright portion of the teak case, and it has seven valves, six of them being of the "V 24" pattern for high-frequency amplification, whilst the seventh valve, which is of the "Q" type, acts as a rectifier. The circuits are similar to those of the standard Marconi type 55 amplifying detectors, but the filament resistance and the potentiometer are mounted on a separate control panel to the left of the amplifier, and are operated by a rotating gear instead of a sliding gear. After the amplifier has been put into operation it is rarely necessary to adjust the potentiometer or rheostat, but they provide a convenient method of reducing the strength from near-by or high-power stations, for in such cases the filaments of the valves may be dimmed and the potentiometer may be moved away from the most sensitive position.

The double-note magnifier—shown in Fig. 9—is situated on the right of the amplifier component and magnifies the low-frequency currents delivered to it by the amplifier in one or two stages. Between the two valves there is a control switch, which has three positions. The first simply passes forward the signals

FIG. 4—TRANSMITTING APPARATUS

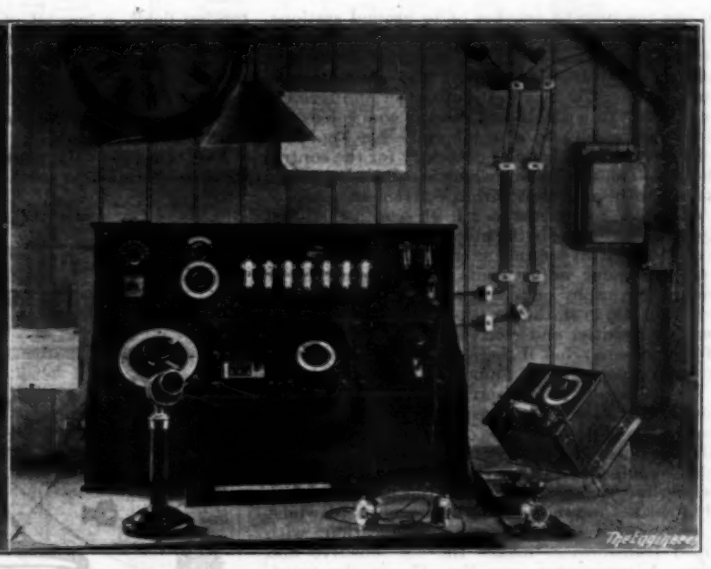


FIG. 5—STANDARD MARCONI DIRECTION FINDER AND RECEIVER

received by the amplifier, while the remaining two provide for single or double amplification as required. The ebonite handle in the centre of the panel controls the filament current of the two valves, and the two sockets on each side connect up the telephones.

Coming now to the method of operation, a bearing on a transmitter from which signals are being received is obtained in three stages, the arrangement of the connections for each being shown in Fig. 13. In the first position the signals from the transmitting source are picked up and tuned-in, in the second the bearing is ascertained, and in the third position the sign or sense of the bearing is determined. The change from one position to the other is effected by means of a key switch, which is situated on the transformer panel and has the three positions which are marked "Stand-by," "D. F." and "Sense." When the switch is in the stand-by position, the mid points of the aerial loops are connected to earth through the primary or sense winding of the air core transformer, and the circuits are arranged for all-round reception. The electromotive forces induced in the aerials by incoming signals may be considered to produce two superimposed effects. The first, or non-directional, effect is due to the action of the combined loops operating as a simple aerial earth system. This effect does not influence the search coil, and it is transferred to the tuning circuits and hence to the amplifying detector and telephones by means of the sense winding of the transformer.

The second effect is due to the action of the aerial loops, as in ordinary loop or frame reception, and is directional. In this instance the resulting circulating currents act upon the detector by way of the search coil and tuned intermediate circuits. The second effect is relatively small, and with the stand-by reception is practically non-directional. The act of placing the key switch in the direction-finding position cuts out the sense winding, so that the tuning circuits can only be affected through the medium of the search coil of the direction-finder component, thus utilising the second effect described. The direction finder combines the signals received on the two aerials in such a manner that the movable search coil is influenced when it lies in a plane corresponding to the direction from which the signals are received, and remains unaffected when lying in a plane at right angles. Hence if the receiving station lies in the plane of the aerial A—Fig. 10—the aerial B will receive nothing, and the search coil must lie in the plane of the field coil *a* in order to embrace as much as possible of the field and receive signals of maximum strength. If under these conditions the search coil lies in the plane of the field coil *b* it will embrace no field, and will receive no signals; but if the transmitter is in the plane of the aerial B, the signals will be received.

If the transmitting source is in a direction which is not directly in the plane of either aerial, signals are received by both, the strength of each being proportional to the cosine of the angle between the direction of the sending station and the plane of the aerial. Thus the two fixed coils set up a resultant field, equivalent to the one which would be created by an imaginary fixed field coil situated between A and B, and corresponding to the direction from which the signals are received. The two aerials A and B, with their corresponding fixed coils *a* and *b*, are equivalent to an imaginary movable system, consisting of one field coil and one aerial, which automatically adjusts itself to lie in the plane of the incoming signals. The plane containing the sending source and the direction finder can therefore be determined by rotating the search coil until the signals are of maximum or minimum strength, but in practice the minimum strength is usually taken, because it is more sharply defined. A pointer moving over a circular scale indicates the position of the search coil, whilst a second but shorter pointer marked "Sense" is fixed at right angles to the long pointer.

With the switch in the direction-finding position, the instrument gives an accurate determination of the plane of reception, but as there are two minima readings corresponding to two bearings 180 deg. apart, no indication is given of the actual direction. One of these bearings is towards and the other away from the transmitting source, and in order to distinguish between them it is necessary to bring the sense winding—shown in Fig. 13—into action. This is done by putting the key on the sense position and holding it there, whilst the sense pointer is put first

at one of the previously determined minima positions and then at the other. A marked difference in the signal strength is then noted, and the circuits are so arranged that when the pointer is in the position for weak or zero signals, the sense pointer will be at or near the previously determined minimum position corresponding to the positive or actual direction of reception. Under these conditions the polar diagram of reception approximates to a cardoid, or heart shape, having a single minimum in the whole 360 degrees sweep of the pointer, this result being obtained by a combination of the first and second effects, extra resistance being introduced in series with the transformer sense winding in order to reduce the currents for phasing purposes.

The aircraft wireless set (typo A D2) which is made by the Marconi Company for use on the aeroplanes—Fig. 14—is designed primarily for telephonic speech from one machine to another or to ground stations, and it can also be used for telegraphic transmission by the movement of a switch mounted on a unit which carries the Morse key. The characteristic feature of the set is that the transmitter and receiver are contained in a single box, and is connected permanently by cables to a small unit—see Fig. 16—which carries all the handles necessary for the control of the set. This small unit, which is called the remote control, can be mounted within convenient reach of the operator, whilst the set itself can be stowed away in the aeroplane in the most convenient position. The remote control equipment enables a pilot to make all the necessary adjustments for transmitting or receiving telegraphy or telephony in a very compact space. For use in the larger types of aircraft the unit type of transmitter and receiver is very suitable and is of neat design; but if there are any small isolated spaces, such as are to be found in fighting machines, the use of a separate receiver and transmitter is recommended. To meet all requirements the Marconi Company supplies both types of equipment.

All the latest developments have been embodied in the combined set shown in Fig. 14. Elaborate screening is provided to obviate the noise which is likely to arise from the working of the magneto, whilst the adoption of high-frequency amplification with damped transformers makes the set sensitive and stable. A variometer—see Fig. 17—in the transmitter enables the wave length to be adjusted to compensate for the variations in the capacity of different types of machines and a single small accumulator serves both for the transmitter and the receiver. The set can be used, as described above, as a pilot-operated set, or, by shortening the various interconnecting cables, the whole combination can be mounted on a single board, when an operator can work the set with greater flexibility than is possible when it is operated with the remote control gear, but a pilot can nevertheless make the equipment meet all his needs.

For supplying the high-tension current for transmission and the low-tension current for heating the transmission valve filaments, a small wind-driven generator is used, as shown in Fig. 15, and this generator also supplies the filament current required by the receiving valves, the current being controlled as required by the "send-receive" switch. An accumulator which "floats" across the low-tension supply and which consequently does not actually supply any power serves as a voltage regulator when the generator speed varies, and also serves to smooth out the ripple produced by the generator commutator. As this accumulator can be switched over either to the transmitter or receiver, considerable weight is saved, and as the accumulator is never allowed to run down, the wireless apparatus is always ready for use, irrespective of the length of the flight. The wind-driven generator has two armatures which are mounted on a common shaft, each armature running in a separate field. One of the armatures is designed to give a pressure of 1500 volts and a maximum current of .1 ampère, whilst the other supplies, in addition to the currents in the high-tension and low-tension fields, a current of 5 ampères at a pressure of from 7 to 8 volts. The field connections and those belonging to the low-tension armature are brought out to a three-point socket, so that the generator can be quickly disconnected from the main wiring of the apparatus if the generator has to be removed from its mounting.

For the 1500-volt positive connection a highly-insulated terminal is used, whilst the common negative pole is connected to the body of the machine. To eliminate noise two condensers—one of .5 microfarad and the other of .25 microfarad capacity—are embodied in the base of the machine, the former being connected across the high-tension armature, and the latter across the low-tension armature. From the smoothing condenser the power leads pass on to the remote control gear—shown in Fig. 16—upon which is mounted the "send-receive" switch and the receiver adjustments. The send-receive switch, which is worked by a control handle, determines whether the power shall be diverted to the transmitter or receiver, and appropriately changes over the aerial connections. The two remaining handles belong to the receiver. One controls the tuning condenser and adjusts the set for the correct wave length, whilst the other actuates a resistance for reducing the loudness of the speech received, when the machine is flying near a ground station. The resistance switch and condenser are mounted on a flat base, which is enclosed by a cover, and all delicate mechanism is shielded. The movement of the handle corresponds to that of an ordinary engine control, and the appearance of the unit is in harmony with the aeroplane design generally.

The remote control gear also forms a junction for all the wires connecting the various units. All these wires are appropriately bunched, and each bunch is separated by a flexible aluminium wire brading which serves as a mechanical and electrical protection, and therefore helps to eliminate the noise that is set up by the magneto as well as tending to prevent pinching or fraying of the contained wires. As the aluminium cover is electrically connected to the metal flexible cable cover, complete screening is obtained. By means of cables the telegraph unit and receiver and transmitting set are connected to the remote control gear, and the set can be disconnected by removing two plugs, one for the transmitting circuits and the other for the receiver circuits.

The transmitter consists of the usual oscillatory circuits for the generation of continuous waves, and the low-frequency control circuits for modulating the intensity of the waves in conformity with the voice. For the generation of the continuous waves there is a power valve and its associated reaction and aerial coils—as shown in Fig. 17. The aerial coil can be wound for any reasonable wave length, but the standard arrangement will give 900 m. by the adjustment of the variometer. The wire used is well stranded, and it is pile-wound so that the electrical resistance and the amount of space required are reduced to a minimum. The variometer is mounted on the aerial coil former, and once it has been adjusted during the course of the trial flight it can always be used without further adjustment. With an aerial of 200 or more feet long a wave length of 900 m. can be obtained with most machines, irrespective of their size. By means of a wave length switch a certain part of the aerial coil can be cut in or out of circuit, so that any set is capable of radiating waves of two predetermined lengths, the standard wave lengths being 900 m. for aircraft work and 600 m. for communication with commercial and ship stations. The reaction coil is semi-variable, but once it has been adjusted on any particular machine there is no necessity for it to be touched again. In the control circuits there are a microphone transformer, a choke and control valves for amplifying the voltage variations of the former and superimposing them on the high-tension supply. This valve instantaneously arranges for an anode voltage sweep on the power valve to vary in accordance with the voice and a maximum variation

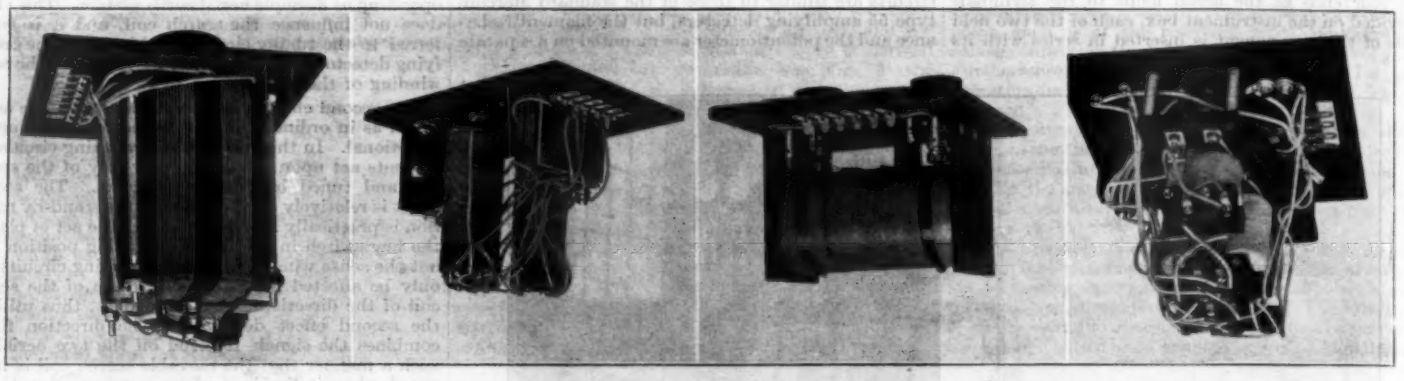


FIG. 6—DIRECTION FINDER

FIG. 7—TRANSFORMER PANEL

FIG. 8—JIGGER PANEL

FIG. 9—NOTE MAGNIFIER

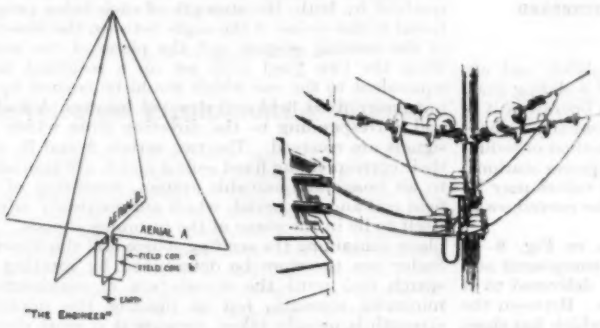


FIG. 10—AERIALS

FIG. 11—LEAD-IN CONNECTIONS

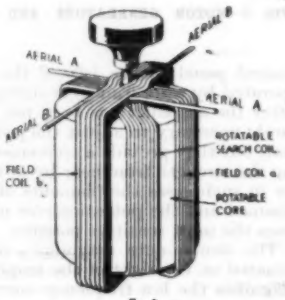


Fig. 7.

FIG. 12—RADIO-GONIOMETER COILS

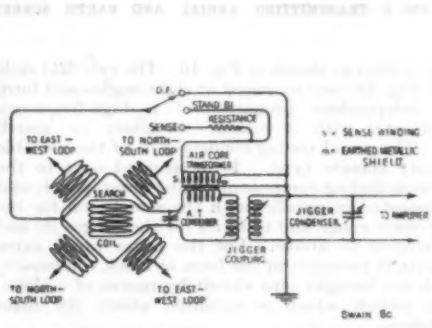


FIG. 13—CONNECTIONS FOR DIRECTION FINDER

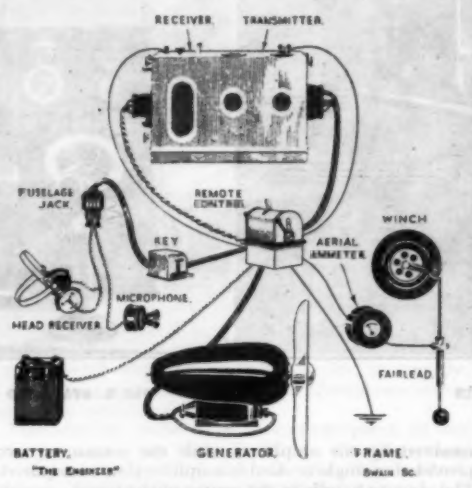


FIG 14—AIRCRAFT WIRELESS SET

of approximately double the voltage normally supplied by the generator is possible.

The receiver is composed of five valves, three of which, as can be gathered from the diagram of connections—Fig. 17—act as high-frequency amplifiers, whilst one acts as a detector and the remaining valve as a note magnifier. Current for heating the valve filaments is obtained from the low tension of the wind-driven generator, whilst the high-tension supply is derived from a battery contained in a box. A condenser embodied in the remote-control unit gives fine variations of wave lengths round about 900 m., but if the set is used as an operator-controlled set, as previously described, it is possible to obtain wave lengths ranging from 450 m. to 1000 m. This range is obtained by the provision of an inductance tapping switch with three working positions, corresponding to short, medium and long wave lengths, the finer adjustments being made by movement of the condenser in the remote control unit.

The aerial coil is inductively coupled to the first high frequency valve through a so-called aperiodic coil, which, when loosely coupled to the aerial circuit, has a natural wave length equal to that of the standard to be worked to. On tightening the coupling, however, the mutual inductance of the aerial and aperiodic coil tends to bring in two possible resonance points, one higher and one lower than the wave obtained with the loose coupling. Thus by varying the coupling of the aperiodic coil, the secondary circuit is tuned, and by varying the position of the coarse wave-length switch in combination with that of the remote control condenser, the aerial circuit is tuned. On a standard wave length, therefore, all the advantages of loose coupling are obtained, but a large range of other wave lengths is possible by a simple secondary adjustment. When pushed home the coupling handle, which is on the left side of the box, gives a loose coupling, whilst when it is pulled out lower or higher ranges are obtainable.

The whole of the high-frequency circuits are screened in a single box, and the aperiodic and aerial coils are also screened from the high-frequency transformers, thus preventing spurious oscillation and giving stability. Reaction is, however, provided so that the set can be made to oscillate and work as an auto-heterodyne circuit for the reception of continuous waves or can be given increased sensitivity for the reception of weak signals by increasing the reaction, the adjustments being made by twisting a handle mounted below the coupling handle. The high-frequency transformers are very heavily damped, so that the reaction adjustment is fully controllable from the appropriate handle, and is not greatly affected by wave length changes or filament brightness. A remote controlled variable resistance enables the valve filaments to be dimmed if the signals prove to be too loud. As low-resistance telephones are used and are connected across a step-down transformer, there is no risk of demagnetising the telephones by the anode current passing through the note-magnifying valve.

The telegraph unit is provided with a key buzzer and a switch. In one of its positions the key is arranged to cut up the continuous waves into Morse signals by opening and closing the grid resistance, and will thus give continuous-wave transmission. In the second position of the switch a buzzer replaces the microphone, when the control valve becomes operative and an interrupted continuous wave is sent out; whilst the third position of the switch short-circuits the key and puts the microphone in circuit in place of the buzzer, when speech can be transmitted. By the simple movement of the three-way switch the pilot can send out any one of the three kinds of transmission—interrupted continuous wave, continuous wave, or telephony. When the pilot gets out of his machine he simply removes a single plug, when he is completely free from all the wireless gear, and he removes his helmet, head receivers, and microphone in one operation. The microphone is hung by a strap round the neck, and whilst it does not impede the pilot's movement it is ready at hand at any moment. In the design of the microphone the special requirements of aircraft work have been kept in view and steps have been taken to render engine noise harmless without impairing the sensitivity to the

FIG. 15—WIND-DRIVEN GENERATOR ON AEROPLANE

FIG. 16—AERIAL WINCH AND REMOTE-CONTROL UNIT

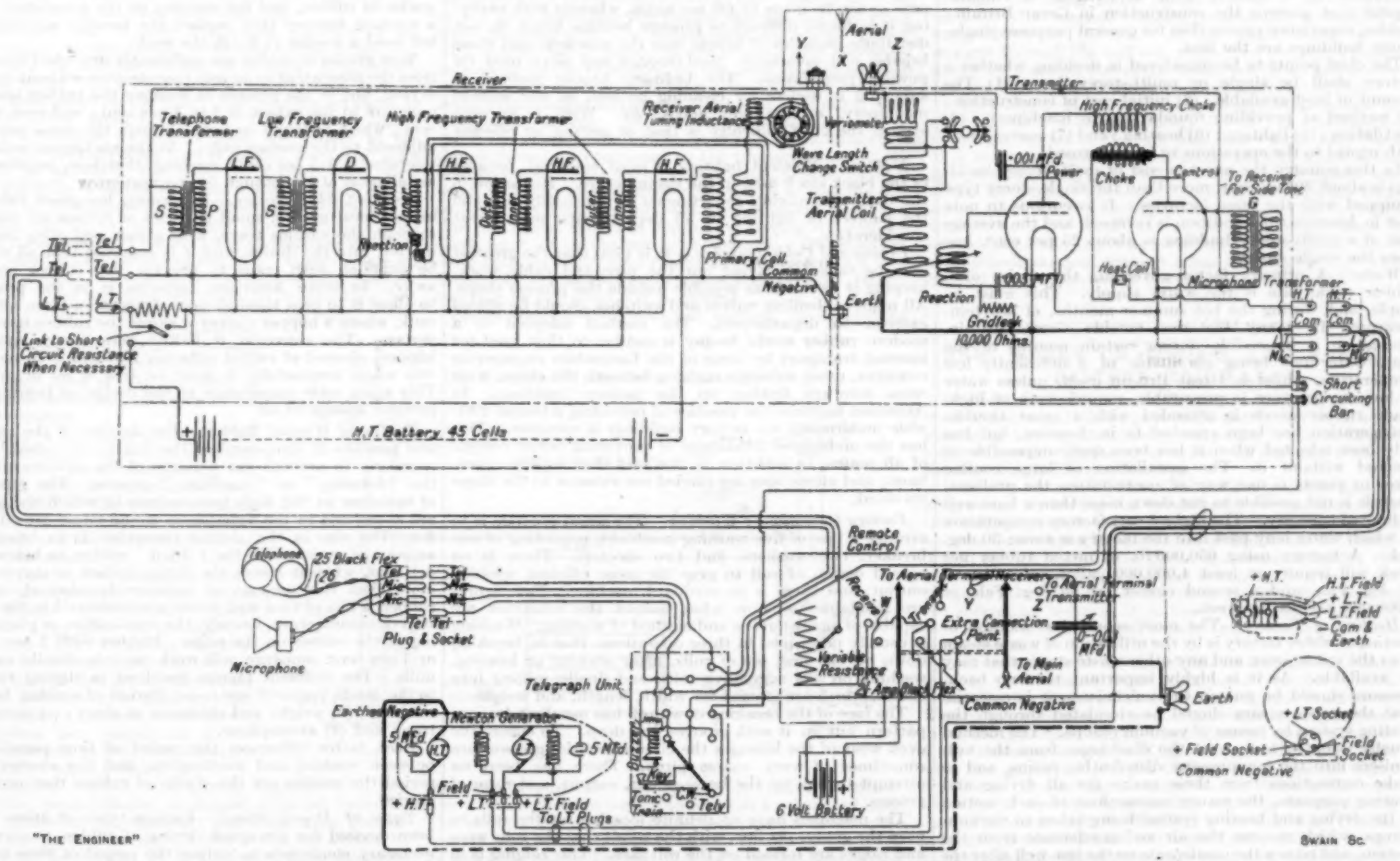


FIG. 17—CONNECTIONS FOR AIRCRAFT RECEIVING AND TRANSMITTING SET

user's voice, which is of relatively great intensity.

It is essential to provide in aircraft wireless telephone installations some means whereby the user of the instrument can overhear his own voice by electrical means, for, owing to engine noises, this is otherwise impossible. The electrical method of listening greatly lessens the tendency for the pilot to shout, provides a check on the quality of the speech, and enables the pilot to decide whether his messages are being understood. The secondary of the microphone transformer is therefore connected at its earthed end in series with the telephones of the receiver. To ensure that unauthorised persons shall not upset the semi-permanent adjustments, locking devices are fitted to the receiver reaction and aperiodic coil, and also to the transmitter and variometer, and these locking devices can only be released by means of a screwdriver. An ammeter is connected in series with the aerial, and is well insulated in order to eliminate the possibility of the pilot receiving a shock. In order to provide for emergency transmission in the event of a forced landing the generator is arranged so that it can be run as a motor generator from accumulators, but this, of course, involves additional weight. In order to eliminate mechanical shock the set is fitted with lugs to which a rubber shock absorber is attached.

The handle of the aerial winch is fitted with a brake, so that all the pilot has to do when letting out the aerial is to draw back the handle and regulate the speed at which it runs out by pressing the handle forward, whilst when the winch is fully wound it cannot run out on its own accord.

Some Mechanical Problems in the Rubber Industry.*

By H. C. YOUNG, of Birmingham, Associate Member.

General Factory Design.—The world's largest rubber factories are in America, where one factory alone is estimated to handle 2,500,000 lb. of mixed rubber, or over 500 tons of crude rubber, per week. The average American factory requires 650,000 lb. per week of mixed rubber, requiring perhaps 120 tons of crude rubber. Outside America there is probably only one factory demanding more than 700,000 lb. of mixed rubber per week.

American rubber factories are mainly built in blocks of about 500ft. in length, and 80ft. to 100ft. wide, with five or six stories. This construction is adopted for the sake of economy, and control in heating—an important consideration in a country with an extreme of climate. Capital cost governs the construction in Great Britain; besides, experience proves that for general purposes single-storey buildings are the best.

The chief points to be considered in deciding whether a factory shall be single or multi-storey are:—(1) The amount of land available; (2) initial cost of construction; (3) method of providing foundations to machinery; (4) ventilation; (5) lighting; (6) heating; and (7) convenience, with regard to the operations to be performed.

In this country the average cost of multi-storey buildings is about 30 per cent. more than the single-storey type equipped with the same facilities. It is curious to note that in America this condition is reversed, and the average cost of a multi-storey building is about 25 per cent. less than the single storey.

Water.—A primary factor governing the choice of a rubber works site is the water supply. This must be ample, and, during the hot summer months, of low temperature. In many factories outside Great Britain, production is impossible during certain months of the year, water not being obtainable of a sufficiently low temperature, whilst in Great Britain itself, unless water of low temperature is procurable, manufacture of high-grade rubber goods is attended with a great trouble. Refrigeration has been resorted to in America, but has only been adopted when it has been quite impossible to proceed without it. The installation of large cooling lakes or ponds is one way of surmounting the problem, when it is not possible to put down more than a bore well of limited capacity. The highest satisfactory temperature at which water may pass into the factory is about 50 deg. Fah. A factory using 650,000 lb. of mixed rubber per week will require at least 4,000,000 gallons of water at 50 deg. Fah. and a second circuit at 66 deg. Fah. of 4,000,000 gallons per week.

Heating of Factory.—The most economical method of heating a rubber factory is by the utilisation of waste steam from the vulcanisers, and any other waste steam that may be available. As it is highly important that no back-pressure should be put on the vulcanisers, it is essential that the waste steam should be circulated through the heating system by means of vacuum pumps. The method usually adopted is to take the discharges from the vulcanisers into the low-pressure distributing mains, and to make connections from these mains for all drying and heating purposes, the return connections of each section of the drying and heating system being taken to vacuum pumps, which remove the air and condensate from the system, and return the condensate to the hot-well after the air has been eliminated. The discharges from the vulcanisers are naturally intermittent and at times give more than can be absorbed in the low-pressure system; consequently, it is necessary to have a suitable arrangement of relief valves, which will prevent the pressure in the low-pressure system rising. When there is not sufficient waste steam from the vulcanisers, &c., to supply the heating and drying requirements, live steam can be admitted automatically through a reducing valve, to keep the low-pressure system fully charged. The savings which can be effected by the utilisation of this waste steam are remarkable, as instanced in five rubber mills. The waste steam from the vulcanisers was used for heating in lieu of live steam, and the savings effected on the total coal consumption of the mills ranged from 15 to 50 per cent. The difference in the savings is explained by the fact that in some of the mills, the proportion of steam used for power was greater than in others. In other mills the power is generated by means of turbines, with a pass-out connection, from which steam is taken at about 60 lb. for vulcanising purposes. If the demand for process steam is large in proportion to the steam required for power, a considerable saving can be effected by the adoption of this system; but if, on the other hand, the demand for process steam is comparatively small in proportion to power, it is probably most economical to leave the turbine purely condensing, and use live steam for the process work, utilising the waste, as explained above.

Ventilation.—The condition of the atmosphere has a definite relationship to the ease of production. The factory should be maintained at 65 deg. to 70 deg. Fah., with the dew point at least 15 deg. Fah. below in shops where there are no solvents, and 20 deg. Fah. where solvents are present. If the dew point becomes high, the shop temperature must go up.

Dust.—One very serious matter the engineer in the rubber factory must face is the dust problem. Chimney stacks, belonging to or adjacent to the factory, stacks of fuel, dusty thoroughfares, rail tracks, &c., should all be on the lee side. The roof and roof openings should be such as to prevent the dust gathering in the gullies and blowing through the openings. Only the minimum amount of overhead shafting and pipework should be tolerated, and provision must be made for regular cleaning of the roof girders. Cement or plaster on the under portion of roofs or ceilings should be fixed, and papered over if necessary, when, owing to vibration, there is danger of flaking. These remarks also apply to the floors, the ideal flooring for a rubber factory being maple. Loads transported on elevating trucks are heavy and the hard floors are ground up by the small diameter wheels, while soft floors develop tracks. One has either much dust or difficult transportation to contend with, but rubber floors might be tried.

In the production of finely ground and calendered rubbers, where articles are made of thin sheets, such as motor and cycle tubes, surgical requisites, cables, &c., specks of dust would destroy the product, and it is, therefore, best to install some system of vacuum cleaning. The act of sweeping up dust in the ordinary way lifts it from the floor level on to the work tables, machines, &c., and the only satisfactory method of surmounting the difficulty is to install a vacuum cleaning centre in each department, with piping running the whole length of each shop, where necessary in parallel lines, with branch tubes for flexible connections, for use with a suitable type of vacuum floor brush.

Sweeping Process Powders.—The advantages of a vacuum system for taking up dust, where the dust is caused by process powders, are pronounced. Powder saved by the vacuum cleaning, as against the quantity collected by ordinary floor sweeping, amounts to about 50 per cent. in recent tests. Powders salved by vacuum process can be made fit for use again, whereas with sweeping it is found difficult to procure brooms which do not distribute particles of bristle into the powders, and these bristles will invariably pass through any sieve used for powder preparation. The ordinary broom method of sweeping is useless for cleaning girders, in and around machinery, mixing mill hoods, &c. With a vacuum system the chief difficulty is that of getting an efficient filter.

Lighting.—Efficient lighting is most essential, because of the black stock used in the manufacture. Reflection in the drug and mixing departments is practically nil, and the subject of lighting in all departments needs great consideration.

Piping and Cable Trenches.—It is vital that the greatest care be taken in laying out the pipe and cable work, keeping it as much as possible outside the process shops. All main controlling valves and switches should be placed exterior to departments. The method adopted in a modern rubber works to-day is similar to that used for internal transport by some of the Lancashire engineering concerns, using subways running beneath the shops, with cross subways linking up the factory buildings. In American factories the practice of providing a tunnel 20ft. wide underneath the factory buildings is common. This has the undoubted advantage of providing better control of all mains, in addition to the fact that repairs, overhauls, and alterations are carried out exterior to the shops involved.

Factory Operations: Washing.—The usual practice is to arrange a line of five washing machines, consisting of one breaker, two washers, and two sheeters. There is no agreed design of roll to give the most efficient washing output, and there is no standard machine. Few figures are available to show what output the machines are capable of against grade and method of washing. Washing is usually performed in three operations, that is, breaking down on the first set of rolls, after soaking or heating, washing on less aggressive rolls, and finally milling into sheets, which are gauged for width, length, and weight.

The face of the breaking down roll has usually a lozenge pattern cut on it with grooves ¼in. deep. To ensure the even wear of the lozenges the circumferential grooves are sometimes of very coarse pitch. There has been no attempt to link up the horse-power, output, and form of groove.

The machines have no definite location for the rolls to keep the grooves in line, with the result that the rolls wear and ridges are formed on the roll face. This ridging is in effect a series of saw-teeth on the front and back roll, which fit into one another, and the rolls in this state have a very poor appearance. It has been found by horse-power tests that these much worn rolls are actually as effective as new ones, and this suggests that the rubber is better worked by a roll with tooth meshing. Owing to the quantity of water continually going into the nip of the rolls, there is no necessity to have them bored, to carry away the heat generated by the milling operation. When starting up cold, steam connection must be made for heating the rolls. A battery of five washing machines, with roll lengths between the cheeks of, say, 30in., requires 150 horse-power. The machines must be designed so as to prevent oil and grease from the bearings creeping on to the roll face, which, besides affecting the rubber, causes slippage. In addition, sand, grit, and acid from the rubber must be prevented from working into the bearings. Water should not be allowed to wash out the lubricant, nor should rubber be allowed to lodge between the roll necks or behind the guide-plates. The design of the breaker and washer rolls must be such as to permit no unbroken ridges of rubber to pass through the nip; an efficient washer should break open every particle of rubber, and allow the water to wash out all foreign matter.

The arrangement of drive for best production is to have the rolls free for approach from front or back, which necessitates the back shaft being placed above the machine or below. The back shaft being placed a little above floor level, and at the rear of the machine—see Fig. 1—is best purely from the maintenance and attendance point of view. Placing the line shaft over the battery has the disadvantage of casting shadows on to the nip of the roll, and makes it possible for grease and oil to drop on the working portion of the roll. This arrangement keeps the shaft away from water, grit, and acid, but attention from the engineers is then likely to interfere with production. The line shaft placed below the rolls, giving a clear floor space in front and behind the machine, was the practice adopted when mills were direct driven by steam engines, and many more mills were driven off the one shaft than is the custom to-day. With a long line of mills, to make shop transport possible and to avoid the use of ramps, the line shafts were placed below the floor level. This position for the shaft makes it more difficult for maintenance, repairs, and replacements to be effected, and the difficulties of inspection and attendance are increased. With regard to ratio of back to front roll speed of friction ratio, there is no doubt that even speed rolls give less output, and less working and tearing of the rubber, and also increase the pressure on the bearing. There is no settled rule governing the friction ratio. The type of roll varies considerably, but tests indicate that the coarser the pattern on the roll, and the deeper the grooves, the better the results. Most makers supply rolls made of chilled cast iron. In practice these are not the best because they allow too much slipping; a good grey iron gives a far better result, and although the rolls have to be renewed more frequently than those of chilled cast iron, if the rough surface can be retained, it pays to use the non-chilled roll in spite of the increased cost of the roll renewals. With chilled cast iron rolls pieceworkers have been known to use sand to get the rolls to grip. The wear on the rolls and bearings is very considerable, because of the action of sand, water, and acids from the rubber.

Universal Washer.—The totally enclosed washer with fixed centre rolls—see Fig. 2—is the alternative to the standard mill. The action of this machine is to tear the rubber with two fixed centre rolls possessing a deep corrugated faces, and as the rubber passes through the nip it is split on the knife-edge below the nip and turned over by a further nip before going through again. The whole is contained in a water-tight case, so arranged that it can be flooded with either hot or cold water, which washes away all loosened sand, grit, and other foreign matter. These machines are used with profit chiefly for the lower grades of rubber, and for washing on the plantation. In a washing battery they replace the breaker and washer, but need a sheeter to finish the work.

Most grades of rubber are sufficiently dry when received from the plantation to go into manufacture without special drying, but in the process of washing the rubber absorbs moisture to the extent of 2 to 3 per cent., and even 4 per cent., which is found uniform through the mass, and not adjacent to the surface only. As the maximum moisture tolerated is 0.5 per cent., washing, therefore, requires the installation of a thorough drying system.

Washing, Shop Drains.—In washing low-grade rubbers, in fact most grades, small particles of rubber are washed through the various trays, with grease and other foreign matter, into the drains, and it is essential that all drains be supplied with traps to prevent this rubber getting away. In some American factories it is the practice to allow it to pass through open drains to a large settling tank, where a hopper conveyor skims the rubber from the surface. The conveyor is halted periodically and the hoppers cleaned of rubber adhering to them. To reclaim this waste successfully it must be free of oil or grease. This again adds importance to the design of bearings to prevent leakage of oil.

Drying of Washed Rubber.—The dryness of the rubber and powders in compounding the "mix" or "dough" is necessary to prevent the porosity of the mixture during the "forming" or "moulding" process. The presence of moisture at the high temperature to which the goods are submitted in the vulcanisers would cause blow-holes, &c. The aim in the drying operation is to bring the amount of moisture in the "dried" rubber to below 0.5 per cent. when it leaves the drying cellars or stoves. If more than this amount of moisture is retained in the rubber, a loss of time and power is experienced in the next step of manufacture, namely, the mastication or plasticating of the rubber on the mills. Rubber with 2 per cent. or 3 per cent. moisture will work up into crumbs on the mills. The different factors involved in drying rubber to the limits required are:—(*a*) Period of soaking before washing; (*b*) weight and thickness of sheet; (*c*) temperature; and (*d*) atmosphere.

Each factor influences the period of time permissible between washing and mastication, and the shorter this period the smaller are the stocks of rubber that need be carried.

Types of Drying Stoves.—Various types of driers have been devised for the quick drying of rubber to give the necessary conditions to reduce the period of time to the minimum consistent with quality, and the first form is that of the ordinary warm air chamber. The operators must enter the hot cellar to hang and remove the rubber, which is a great drawback. The temperature is usually about 110 deg.–120 deg. Fah., and is maintained at the period of time required for drying, which, including loading and unloading, is about seventy-two hours. The latest American drier is a distinct advance on most drying schemes. In this drier—Fig. 3—advantage is taken of a high temperature, the drawbacks of which are overcome by simple means. The sheets are laid on trays, which prevent the rubber dropping; the trays are placed on trucks capable of being loaded at the washing mill, being pushed directly in the drier as required, and removed when the rubber is dry. This obviates the operators having to work in the high temperature and unpleasant

* The Institution of Mechanical Engineers.—Abstract.

atmosphere of the stove. In addition, the drying may be a continuous process without cooling of the chamber to any appreciable degree. Possible oxidation of the rubber is prevented by humidifying the warm air in the drier, and it is claimed in addition that this humidified warm air softens the rubber, giving subsequent saving of power in the next process, namely, that of mastication.

The drier consists of a chamber surrounded by an air space to prevent radiation or loss of heat. The air flows in at the bottom of the stove, at each side through small ducts, and then passes through steam-heated radiators and over a tank of warm water, as shown. The outlet for the moist air consists of a trunk arranged at the bottom of the drier and connected with a stack, the circulation of the air depending entirely on the displacement of the cold air. The temperature maintained is 160 deg. Fah., and the period of drying is twenty-four hours. Drying in six hours is claimed for this coil.

Vacuum Drying.—The drawback to this type is that a large amount of handling is involved with a limited output; the drier is, however, very effective.

Masticating and Mixing Mill.—The function of the mixing mill is to prepare the rubber for taking drugs, &c., and to mix the drugs and rubber thoroughly to produce a uniform mass. To mix the rubber thoroughly, it must first be masticated on the mill. The rolls are set tight up and the batch ground through. This method has a distinct advantage, in that it cools the rubber at the "nip"; for the rolls being bare of rubber they cool more readily. In addition, the sheet of rubber cools very considerably as it enters the tray. This method can be arranged to be automatic. The alternative method is to allow the rubber to embrace the front roll, then continuously cut it over by hand, changing the rubber so that a fresh layer always embraces the roll. If there were no "cutting about," the rubber would be unevenly worked. Neither of these methods can claim to be anything but elementary, but it is safe to say that 95 per cent. of the world's rubber mixing is being carried out by one or other of them. The lack of control of speed, mill friction, and temperature, give rise to the need of experienced workmen, particularly on delicate mixings.

So heavy is the horse-power bill for rubber mixing that many remedial devices have been introduced, but until quite recently no real advance has been made. The totally enclosed automatic mixer has now become established, and has reduced the horse-power consumption by half, but it does not possess the flexibility necessary for the standard milling operation. Makers of automatic mixers claim for this type of machine:—Uniformity of mix; control of temperature; less punishing of the rubber as the work is done throughout the mixing chamber and not in a nip; reduced labour costs; reduced horse-power consumption per pound of mixed rubber; removal of the dust nuisance and saving of waste powder.

The machine consists of a mixing chamber with two fixed centre mixing blades, so shaped as to cut open the mass of rubber in the chamber, and continually present new surfaces to the machine; it also brings the surface in contact with the drugs. To be successful these machines must be efficiently cooled, of ample mechanical dimensions, and should be fitted with a couple of rolls for sheeting out, as the batch just tumbled out of the mixing chamber is awkward to handle, and likely to burn unless sheeted out quickly and allowed to cool. It is very questionable whether they are capable of mixing satisfactorily stock when sulphur has been added; the best results so far have been obtained by adding sulphur on the sheeting mills.

Standard Mills.—The trouble of dust from powders which choke the oil-holes, and cause hot bearings is a serious one. The batch of rubber and ingredients to be mixed with it, is weighed on to the mill, and weighed again when taken off, and must be within a given tolerance. It is important that nothing should lodge between the neck of the rolls and the guide plates. A few ounces of each batch can accumulate, and this, when of sufficient mass, is gripped by the rolls, and pushed into the tray, the result being that the particular batch is scraped on account of excess weight. It is imperative that the design of the mill should be such as to keep the weight of the batch constant.

Bearings.—In mixing mill design, owing to the excessive pressure on the bearings, and the fact that, with the rolls empty, they float away from the usual load position and return with a thump on load, lubrication is an important factor, and the metal linings for the bearings need closest attention. If the metal be too soft, it will roll out as much as ¾in. endwise. Under the load the bearing heats up, but this heat is carried away by the roll cooling water. Even then trouble arises from hot bearings, and it is questionable whether a special housing giving a clean face for the production, and housing the bearings and wheels would not pay.

End-wheels.—The end-wheels should be designed to have their centres moved over a range of ¼in., and unless ample strength is provided the teeth fail. Nearly all cases of roll neck breakages are caused through the end-wheel teeth breaking first. In several mills end-wheels of steel with double helical teeth—machine cut—were discarded because of excessive ridging on the pitch line, in addition to rapid wear of teeth. In their place, ordinary cast iron gears with straight teeth were fitted, and gave much more satisfactory service. No figures are available showing the horse-power taken by the back roll, but undoubtedly this is directly proportional to the friction ratio. If the braking bush, remote from the end-wheel, breaks, the end-wheel will jam, because more rubber trins to pass the nip, and the roll opens right out at the end when the bush fails. This movement should be limited by placing stops in the check front, or on the side of the bearing. On breaking-down rolls on which cold rubber is first treated cast iron double helical gears fail every time a bush breaks. Heavy grooving on the pitch line is general.

Safety Bushes.—The standard method, as in washing machines, is to fit a bayonet flange bush, taking the adjust-screw, and reduced in section to break at a calculated load. The method is extremely crude, yet practically all mills now running have this type of bush. If cold rubber is fed on to a plain roll rubber mill, it is fairly certain that a bush will break. Overloading a rubber mill may be very disastrous and must be guarded against. Attempts have been made to reduce the cost of the bush replacement by applying discs, steel bushes, and by special screw lining, but these have the fault of failing under load. The ideal bush is one that does not move until the fixed pressure point is reached. Hydraulic systems have been successfully applied, but their cost is high.

Roll Adjustment.—Little or no attempt has been made to arrange for parallel adjustment of the rolls, and considerable damage can be caused through uneven roll setting apart from the uneven working of the rubber. Plantation rolls have a parallel motion gear fitted, which, when once set, can be locked. Most existing mixing plants have not even an efficient indicator showing the position of the roll, and some device is necessary which will indicate clearly the roll position and will allow for wear of bearings.

Roll Faces.—Chilled iron has generally been used for mixing mill rolls, but this is not necessary. A good grey cast iron will not only reduce the weight of the roll, but will permit much more efficient roll cooling. Rolls in chilled cast iron 4½in. thick, which have been broken on load, have been replaced, with safety, by rolls 3½in. thick in cast iron, resulting in a considerable saving of water. The latest practice is to use 2in. steel rolls. These were installed first by a British rubber company, and have resulted in lower temperature of mix giving at the same time 60 per cent. saving in the water consumption. The only objection to the steel rolls is that they are scratched by the mixers' knife in cutting off, but this is not a serious objection. The water service of the roll is worthy of attention. The water is supplied to the roll through a special gland connection attached to a pipe feeding the water to the remote end of the roll from the supply. The water returns along the inside of the roll and is discharged through the same gland connection to a return water circuit. This method creates considerable difference in temperature on the roll. If the water could be fed straight through the mill roll, more even roll temperatures would be possible, hot spots would not be so pronounced and the bearings would receive more uniform cooling.

Safety Stop.—If it is necessary to stop the machine instantly, this is done by a safety device. A wire running the whole length of the mill line, and within easy reach of a workman, operates a trip-out switch, which either cuts out the magnetic clutch or the electric motor and allows the brake to operate. In addition, bars are fixed across the front of grinding and warming mills to enable workers to have some sort of support, if one hand is caught, until the trip wire is touched. Operators' hands can be badly injured without going into the nip, by being gripped by the hot wedge of rubber.

(To be continued.)

FIG. 1.—*Various Drives for Mills.*

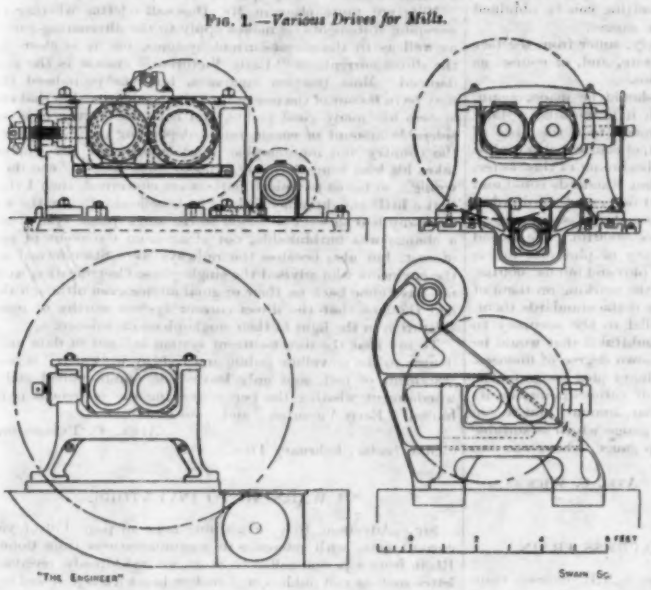


FIG. 2.—*"Universal" Washing Machine* (Perkins).

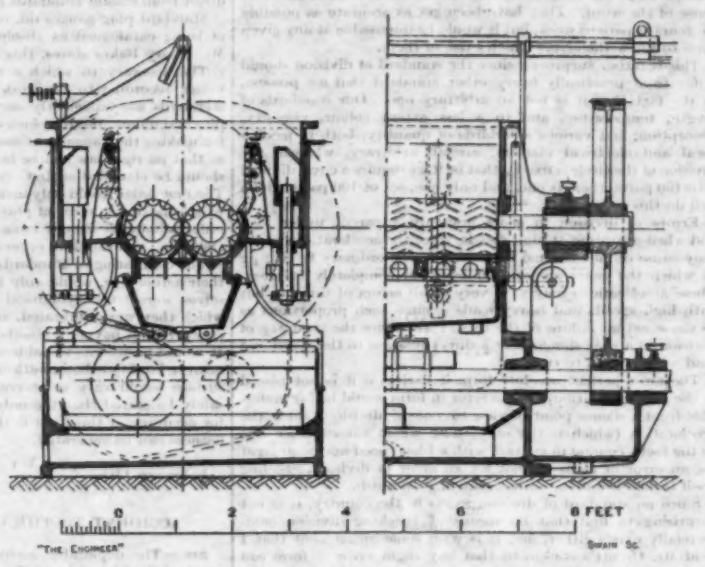
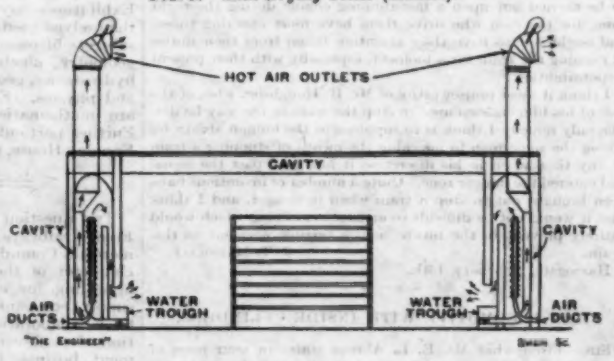


FIG. 3.—*Kiln Drying Cellar* (Hunter).



NEW WORKS ON LONDON AND NORTH-EASTERN RAILWAY.

IN the annual article on railways which appeared in our issue of January 12th we gave some particulars as to what was being done by the railway companies to relieve unemployment, and we referred to what was contemplated by the then North-Eastern Railway.

It is now announced that that company has in hand a programme involving an expenditure of approximately two million pounds. The greater part is for works that have as their object the provision of additional accommodation for the working of goods and mineral traffic, the most urgent need at the moment being, in the view of the company, the provision of adequate facilities for handling the increasing business it is being called upon to carry as a result of the general steady improvement of trade in the country.

Among these works are the additional facilities necessary to carry the increased traffic anticipated from the opening of the British Empire Exhibition and Sports Stadium at Wembley, mentioned in the annual article already referred to as being in hand on the Great Central, construction of a new locomotive yard at King's Cross, widenings on the main line, and the Harworth Colliery branch on the Great Northern. In addition to these works, there is the construction of the new line, jointly with the Metropolitan, from Rickmansworth to Watford, a mineral line, 7 miles in length, from Waltham to Colsterworth, and the equipment of the Enfield and Stevenage loop, now used for goods traffic, for passenger trains.

In addition to the works at Darlington, South Gosforth, Sunderland, Bensham, and the High Level Bridge, Newcastle, which we mentioned as in hand on the North-Eastern, important alterations are to be effected at Hull docks, particularly in connection with the fish traffic. New dock gates, electric pumps, &c., are to be provided. Numerous works at West Hartlepool and Hartlepool for improving the means for dealing with coal traffic and alterations to the passenger station are in hand. The entrances to the Tyne Dock are being renewed, and new cranes, turntables and additional siding accommodation provided. The up goods yard at Heaton is being rearranged, and additional sidings laid down. Important alterations in the signalling are being made in Waverley Station, Edinburgh, to provide better working facilities.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE ACCURACY OF GEAR WHEELS.

SIR,—I have read your editorial on the above subject with extreme interest, and notice that while the accuracy of gears is referred to in a general manner no mention is made of the particular accuracy required in the different elements of the tooth.

A great deal of controversy has been launched in the columns of the technical Press extolling the virtues of one or another particular kind of tooth form, but no mention appears to be made anywhere of the necessity for placing the tooth in its correct position.

This depends mainly on two errors, viz :—Concentricity and division. Errors of concentricity are easily checked, but errors of division are not, and it would seem that no standard of division exists in the country, unless the graduating machines owned by some makers of astronomical instruments can be termed such, but they themselves are not standard in the true sense of the word. They have been got as accurate as possible by years of patient work, but it would be impossible at any given time to know the errors which exist in them.

This is rather surprising since the standard of division should differ from practically every other standard that we possess, in the fact that it is not an arbitrary one. Our standards of length, temperature, and to a less extent colour, viscosity, absorption, and various standards of quantity, both in mechanical and electrical matters, are all arbitrary, whereas the division of the circle is fixed ; that is, if we require a circle divided into 100 parts, there is one, and only one, set of 100 parts which will do this accurately.

Errors of division in gears are only apparent under load and when operating at high speeds, since the accelerations which they cause do not become noticeable in the ordinary testing jig in which the gears are rotated by hand completely in mesh. These accelerations may with very small errors of division but with high speeds and heavy loads assume such proportions as to cause actual failure of the teeth ; therefore the accuracy of division in a gear should bear a direct relation to the speed and load which it has to transmit.

The most perfect involute form is useless if it is not placed in the correct position, and an error in form would be far preferable from a silence point of view to one of division, since the acceleration (which is the only thing which causes noise due to the teeth coming in contact with a blow) need not be so great for an error of form as that for an error of division. Sliding itself is noiseless if the surfaces are of good finish.

Since no standard of division exists in the country, it is not surprising to find that no means of checking division commercially exists either, and it is with some amazement that I read Mr. Orcutt's statement that any slight error in form can be felt by placing the gears upon two pins and feeling for the defect, and, moreover, the character or type of error which exists, so that a slight change of the formers which control the diamonds could be carried out and the noise disappear. Obviously, in order to make the correction, the skilled man must be able to feel the amount of the error.

Assuming that this seemingly impossible thing is attainable by the skilled man, it would appear that the formers were wrong in the first place, and surely it is not suggested that the human touch will find something which remains hidden from either examination with the projection machine or microscopic measuring machine. This calls to my mind a very convincing analogy given by James Hartness in his projection machine booklet where he pictures a nigger with his hand on a steam boiler saying " by the feel this boiler has 66 lb. pressure."

The " feel " method is one which depends entirely and completely on the personal element of the observer, a thing it is most important to eliminate if accurate results are to be obtained. Then again, according to Mr. Orcutt, not only is the defect discovered, but the type of defect is also reasoned out by the " feel " method. It would be interesting to know what difference in feel there is between two gears which become tight due to an error in form or due to an error in concentricity. It is very similar to a man putting a screw in a ring gauge and telling what is wrong with it by its feel or fit.

That gear grinding will become standard practice for high-speed gears there can be no doubt whatever, but means must be at hand for accurately measuring gears not only for form, concentricity, centralisation of the tooth and parallelism of the tooth with the axis of the gear, but also for division.

In dealing with any new subject the speed at which we can progress in that subject depends upon the rate at which we can obtain accurate data, and accurate data cannot be obtained without accurate measurement. At present the whole system of gear manufacture is based on " cut and try " principles.

The grinding machine will produce results which are amply fine enough to give us silent gears without selective assembly, but the machine must be equipped with division plates of extreme accuracy. The division plate is in circular division what the end standard is in lineal division, and the worm and worm wheel can be compared with the micrometer. We know that the micrometer, due to wear, needs constant calibration against end standards ; in the same way the highest accuracy in a gear-grinding machine can only be obtained by the use of division plates, and their accuracy should be capable of being checked up at any time so that if outside the limits allowed they can either be re-ground or scrapped.

A worm and worm wheel on a gear-generating machine seems to be allowed to wear for ever. No manufacturer ever scraps it even if the machine is twenty years old, and since he has no means of measuring its error, naturally to him the error does not exist.

AXEL C. WICKMAN.

February 14th.

[It is worth noticing, in connection with this letter, that Mr. Orcutt uses a notched division plate and not a worm and wheel.—ED. THE E.]

MADE *VERSUS* PURCHASED GAUGES.

SIR,—It is true that my recent letters in your journal regarding the accuracy of gauges were intended to cover those made by works for their own use, but the question which Mr. Henry Baker the raised is also one of paramount importance.

The tolerance on a gauge depends to a very great extent on the tolerance on the component which it has to test. It is a safe rule to allow that wherever possible the wear limit on the go-gauge coupled with the manufacturing tolerance and errors of standardisation of the go and not-go gauges should not exceed 10 per cent. of the component tolerance. This unfortunately is not always possible.

Referring again to my example of a 1in. Newall class " A " hole, the tolerance is plus and minus .00025in., and our recommendation for a gauge for this tolerance is as follows :—

High limit, or not-go end, to be + .00025in.
+ .0002in.

Low or go end, — .00015in.
— .0002in.

This gives a minimum wear allowance of .00005in., and a similar accuracy for the go and not-go ends of the gauge. This accuracy has to include all the errors of standardisation and workmanship, and is therefore an extremely fine tolerance. The minimum tolerance available in the shop can be as low as .00035in. and the maximum when the go gauge is fully worn and the not-go still up to size .0005in.

This, I think, amply demonstrates the difficulty any firm has in making its gauges and working to such a fine tolerance as Newall class " A," unless the work were so special as to enable systems of gauging to be used, such as direct amplification gauges, where re-setting could easily allow for any slight wear that takes place, and where the setting can be obtained direct from master standards such as slip gauges.

Standard plug gauges do, unfortunately, suffer from the fact of being catalogued as absolutely accurate, and, of course, as Mr. Henry Baker states, this is ridiculous.

The accuracy to which a standard should be made, again, varies according to the work for which it is required. Many standards are sufficiently accurate if made to a tolerance of plus and minus .0001in., such a standard, of course, being useless for making the gauge mentioned in the beginning of this letter, so that no rigid law can be laid down, but standards could and should be classified as first order, second order and third order. The first order would only include such standards as slip gauges, with a maximum error of plus and minus .00001in. The second order standards should have an accuracy of plus and minus .00005in., and the third order standards plus and minus .0001in.

The calibrating of standards, that is, the marking on them of their actual size, would only be suitable if the standards themselves were truly cylindrical and parallel to the accuracy to which they were calibrated, and it is doubtful if that would be cheaper than having a standard of a known degree of fineness. It would be useless to calibrate an ordinary plug gauge to the nearest hundred-thousandth of an inch if various points on its surface would vary to several times that amount, and it can safely be stated that the only type of gauge which is suitable for accuracy of this kind is the flat slip gauge, whose size and flatness can be generated.

AXEL C. WICKMAN.

February 14th.

ACCIDENT TO THE G.N.R. EXPRESS TRAIN.

SIR,—The deplorable accident to the G.N.R. express train north of Retford early on Tuesday morning last calls for drastic regulations of the goods traffic upon our main lines. It is inconceivable to think, that with all the experience gained in the running of trains, and the danger which is known to exist by running goods trains in front of express trains, that this is still allowed to be carried on. I am fully aware that upon most railways there are certain sections of the line where trains are regularly changed over from the main line to what is called the slow road ; but it cannot always be done in time to allow the faster train to go on in front of the probably slow goods. It has been my privilege upon many occasions to travel upon the engines of some of our fast expresses, and I can testify to the watchfulness at all times of the driver and his fireman to the safety of the running of their train, and their vigilance in observing the signals in front of them, more especially during the night time. The driver always is stationed upon the right side of his engine when going forward, and the fireman on the left side on the look out also when not engaged with his other duties. There are, however, times which I have noticed more than once, especially when rounding a curve and the fireman in the act of firing, that a red light would suddenly appear in front which the fireman would have been the first to see, being on the left-hand side, had he not been otherwise engaged. Of course, this means that the train is carried further on before the driver can see his signal at danger. I think it very undesirable for any experiments to be carried out upon a fast-running engine during the night time, for the men who drive them have most exacting times, and ought not to have their attention taken from their duties of running the train for a moment, especially with their present responsibilities.

I think it most praiseworthy of Mr. H. Houghton, who, at the risk of his life, endeavoured to stop the train in the way he did. The only remedy I think is to supplement the human ability by giving the signalman in his cabin the means of stopping a train at any time when in his discretion it has gone past the signal and entered the danger zone. Quite a number of inventions have been brought out to stop a train when in danger, and I think that it would not be difficult to arrange something which would entirely prevent in the future such a terrible accident as this again.

J. T. MARSHALL.

Harrogate, February 15th.

FIRST LOCOMOTIVE WITH INSIDE CYLINDERS.

SIR,—From what Mr. E. L. Ahrons states in your issue of the 2nd inst., there is no doubt, I think, that the credit for designing the first inside cylinder locomotive (properly so called and with virtually horizontal cylinders fixed immediately below the smoke-box) must be given to Edward Bury, or, more fairly, perhaps, jointly to Bury and his partner, James Kennedy.

It is true that the Novelty (1829) had a pair of cylinders placed between the frames, but they were not only arranged vertically, but were placed some distance from the boiler, in a very exposed position, and were, moreover, not directly coupled to the driving wheels, therein differing in all respects from Bury's design of the same year. Again, the Globe (1830), which went one better than the Novelty in having inside horizontal cylinders disposed beneath the boiler, nevertheless had the cylinders at the fire-box end, a position that was not repeated in subsequent locomotives with inside cylinders and crank axles. For these reasons, neither the Novelty nor the Globe strictly belonged to the same category as the type of locomotives evolved by Edward Bury, in which type the cylinders were arranged very much as they are to-day, where the inside position is favoured.

With regard to Bury's No. 2 Liverpool, there is a story to the effect that the building of this engine was commenced in January, 1831, and that the engine ran its first trial trip on the Liverpool and Manchester Railway in March, 1831, whereupon it was purchased for the Petersburgh Railroad of America. This engine is said to have had 9in. by 18in. cylinders, and 4ft. 6in. four-coupled wheels. I believe that I am correct in saying that this particular " Bury " no one has ever been able authentically to trace.

In my opinion, there is no question that the Liverpool was tried on the Liverpool and Manchester Railway in 1830, and that it had 6ft. wheels. Were there two Liverpools ?

F. W. BREWER.

Stevenage, February 17th.

RAILWAY ELECTRIFICATION.

SIR,—With regard to Mr. Durtnall's letter on the subject of electrification of trunk line railways, I was astounded to see in print such bald statements unsupported by any foundations whatever.

Evidently what you really meant in your leading article was that it is fortunate that this country had not committed itself to any particular system of electrication at this early stage, but has waited for the developments in and experiences of other countries before deciding upon the best system to adopt.

It is not quite clear in Mr. Durtnall's letter whether the sweeping statements he makes apply to the alternating-current as well as to the direct-current systems, but it is clear that the direct-current, or " Early Victorian," system is the more damned. Most traction engineers, however prejudiced they may be in favour of the one or the other system, realise that each system has many good points, and both are worthy of a considerable amount of consideration depending on the nature of the country and innumerable other factors. If Mr. Durtnall takes his lead from Germany, who to some people " can do no wrong," so far as technical matters are concerned, then I think that a little enlightenment would be beneficial. Before the war, Germany had so welded herself to the single-phase system that a change was unthinkable, not alone from the point of view of cost, but also because the railways were State-owned and the engineers who advised the single-phase electrification would not have gone back on their original advice even although they had thought that the direct-current system worthy of reconsideration in the light of their single-phase experience.

To say that the direct-current system is " out of date and a danger to the travelling public and railway workmen " is not a statement of fact, and only leaves one dumbfounded and in wonderment whether the person making the statement is not himself " Early Victorian " and " out of date."

ALEX. D. FERGUSON.

Manchester, February 17th.

A WARNING TO INVENTORS.

SIR,—Adverting to your warning note on page 170 of your current issue with reference to communications from Bonn a. Rhein from a person called O. Stolz, we had already received a letter such as you publish, and enclose herewith a postcard from the same source, which may be of interest to you.

PRECISION PHOTO PRINTING PLANT, LTD.,
per S. H. MORSE, Director.

London, E.C. 2, February 19th.

Bonn a/Rh.,
15th February, 1923.

DEAR SIR,—I am still without answer upon my letter sent to you. If I shall announce your patent to be granted in the States named by you, I ask you kindly to send me on account of the bad standing of our Mark a small advancing of 1 to 2 Pounds (in a registered letter) Please by retourn of post.

I have sufficient plans of your patent at hand. And I would not wait any longer with the selling of the different patents.

EDUCATIONAL INTELLIGENCE.

THE annual examinations for a Faraday Scholarship of fifty guineas per annum, tenable for two years in college and one year in manufacturing works, and for a Maxwell Scholarship of fifty guineas per annum, tenable for one year in college and one year in works, will be held at Faraday House, on April 10th, 11th and 12th, 1923. Exhibitions may also be awarded to candidates who acquit themselves creditably in the above examinations. The subjects of examination for the Faraday Scholarship are geometry, algebra, trigonometry, dynamics, statics and hydrostatics, geometrical and freehand drawing, chemistry and physics. For the Maxwell Scholarship the subjects are mathematics, dynamics, statics and hydrostatics. Further particulars may be obtained from the secretary, Faraday House, 62–70, Southampton-row, London, W.C. 1.

THE question of the electrification of the whole of the French railways is being studied by a Parliamentary Commercial Committee. Stress is laid on the national character of the scheme, and also on the necessity of appealing for close collaboration between the electric supply companies, the railways, and the Government. Such collaboration is to be put into practice by the formation of a sub-commission composed of members of Parliament, business men and qualified technical experts, who will prepare a report dealing with the practical side of the question for submission to the committee. A message from Berne says that Switzerland is issuing a loan of 200 or 250 million francs—£10,000,000—to provide funds for the electrification of the Swiss railways.

THE weight of freight traffic conveyed on the railways of this country during the month of November, 1922, was greater than in any month since March, 1920, and represented an increase of 23 per cent. over November, 1921. The tonnage of general merchandise increased by 8.3 per cent., coal, coke and patent fuel by 25.3 per cent., and other minerals by 32.9 per cent. The record of these exceeded the figures recorded for any month since monthly particulars became available—January, 1920. The average length of haul for all traffic fell from 55.3 miles to 51.5 miles. While, therefore, the increase in tonnage was 23.0 per cent., the increase in net ton-miles was only 14.6 per cent. Total freight receipts showed a decrease of 5.9 per cent., compared with October, 1922. The freight train-miles run were 9.5 per cent. more, and the average train load increased from 126 tons to 131¾ tons.

A Seven-Day Journal.

Coal Dust Experiments.

ALONG with others, three members of the South Staffordshire and Warwickshire Institute of Mining Engineers were recently invited by the Mines Department Research Committee to witness the results of coal dust explosions at the Government's experimental station at Eskmeals. Their reports were presented to the Institute at its meeting in Birmingham on Monday. In the first report Messrs. Holland and Ridsdale united with the third representative, Mr. J. R. Felton, an inspector of mines, in recording the results of their observations; but in the second they dissociated themselves from the Government official, and criticised the method of conducting the experiments. They urged that additional experiments should be carried out, and in particular that trials should be made with dusts obtained from the different coal-mining areas in the presence of representatives from those areas. The dusts used should, they argued, be collected from typical mine roads, or should be such dust sieved through a 28 mesh instead of being pulverised coal, the bulk of which would pass through a 200 mesh. The explosion in the experimental gallery was, in their opinion, or so we gather, exaggerated in its violence over what would occur in the mine by reason of the employment of dust of too fine a nature, by reason of the excess of dust distributed in the neighbourhood of the cannon and by reason of the artificial manner in which the explosion was initiated. On the other hand, while impressed by the effect of stone dusting in stopping the development of the explosion, they found that even with a one-to-one mixture of stone and coal dusts the flame of the explosion travelled about 200ft. from the cannon before dying out, so that it could not be held to eliminate all danger, especially in a fiery mine. They suggested, therefore, that experiments should be continued with stone dust until it was found possible to stop the explosion at the point of ignition.

Protection for Commercial Motor Vehicles.

FOLLOWING the efforts being made by the Association of British Motor Manufacturers to secure the protection of the Safeguarding of Industries Act for the commercial road motor vehicle, petitions are now being received at the House of Commons from groups of workmen employed in the industry, urging that the same duty should be imposed on foreign commercial vehicles as that levied on touring cars. On Monday three such petitions were received, one from J. and E. Hall's works at Dartford, with 650 signatures; another from the Austin Company's Birmingham works, with 500 signatures; and one from the Tilling-Stevens works at Maidstone, with 430 signatures. The object of these petitions is to relieve the depression at present prevailing in the industry and to prevent the necessity for dismissing more men or for introducing a greater degree of short time.

Solvent Recovery in the Rubber Industry

ELSEWHERE in this issue the reader may study the remarks made by Mr. H. C. Young at the meeting of the Mechanical Engineers last Friday regarding the mechanical aspects of the rubber industry. In view of the criticism to which he subjected the design of the machinery and plant used, it would be interesting to learn what exactly the rubber manufacturers themselves think about the efficiency of the processes they employ. So far as one item in the count is concerned, our curiosity in this respect has been satisfied by the remarks made at the meeting on Monday of the Manchester Section of the Institution of Rubber Industry. The subject under discussion was the recovery of solvents, such as ether, acetone, naphtha and benzine, used in the industry for the coating of fabric with a deposit of rubber and for similar purposes. The criticism levelled against the common practice in this matter followed by British manufacturers far surpassed in severity anything that Mr. Young said in his paper. One speaker characterised the practice of puffing the solvents into the air as wanton waste, and described the use of solvents without recovery as "perhaps the crowning example of stupidity." The author of the paper under discussion stated that the Americans appeared to be leading the way in the recovery of solvents by the absorption process, and suggested that the American manufacturers were less conservative, more adventurous and saw more clearly the advantages of new conceptions than those in this country.

Reduced Wages and Increased Hours.

IN the course of a statement regarding wage reductions and increased hours of work, issued by the General Council of the Trade Union Congress, it is remarked that organised labour will not adopt a policy which will hinder a revival of trade, but that on no account will it agree to any change which will lower the conditions of employment, even though such change may be proved to be helpful to increased output and trade revival. It is to be inferred from the statement that the Council views proposals for lengthening the working day with more alarm and disfavour than schemes for the reduction of wages. The attainment to a working day or week of reasonable duration is characterised as the principal advantage secured by trade union effort extending over more than sixty years. It is argued that the conditions of modern industrial development, notably the specialisation of industry and the subdivision of labour, limit the opportunity for mental development in connection with industrial occupations, and that the worker requires compensating opportunities to enable him to devote some portion of his life to the duties of citizenship and the responsibilities of domestic affairs. It is added that a trade revival without industrial peace is impossible, and that industrial peace is out of the question if attacks are made on organised labour for the purpose of securing extensions of the normal working day or week.

Disinfecting Liners and Railway Carriages.

NEW regulations for the fumigation of ships have been made by the United States Treasury. They are designed to permit in certain circumstances the extension of the six-monthly period of fumigation previously required. The circumstances taken into consideration in granting extension all bear upon the absence of rats on board the vessel. The regulations from the technical point of view are chiefly interesting because they permit and give instructions for the use of cyanogen chloride gas in place of pure hydrocyanic acid gas. This new fumigant is highly lachrymatory—a feature of advantage in its employment by virtue of the warning which it gives in this way that traces of it are still present in the compartments which have been fumigated. The gas, it is admitted, tarnishes metals. Since the fumigation of railway coaches as well as of liners by means of prussic acid gas, or compounds of it, is now being adopted—in India, for example—it is advisable to note that strong suspicion is felt in some quarters that the practice is attended with grave danger. It is believed that cushions and other articles may absorb the gas, and days afterwards give it up again upon a rise in the temperature. On the Polish railways, it is stated, so many fatal accidents have occurred, presumably from this cause, that the use of hydrocyanic acid gas as a fumigant has had to be abandoned. There is no assurance that cyanogen chloride gas is less dangerous in this respect than hydrocyanic acid gas, but doubtlessly its lachrymatory character would be some protection against the occurrence of fatal accidents to passengers.

Lord Claud Hamilton Retires.

THE retirement of Lord Claud Hamilton from the chairmanship of the Great Eastern Railway is now an accomplished fact, for on Tuesday he addressed the company's shareholders for the last time. He is now eighty years of age, and has served the company as a director for a period of fifty years, during thirty of which he filled the position of chairman. He has seen the birth and growth of the enormous suburban traffic now handled from Liverpool-street. At the outset that traffic proved highly profitable, but municipal "enterprise" led to severe competition, with the result that not only did the company lose some of its traffic, but as a very large ratepayer was called upon to shoulder a considerable proportion of the financial burden created when any of the municipal transport schemes were worked at a loss. Dealing with his associations with the North-Eastern in the current number of that line's monthly magazine, he criticises the plan adopted for Liverpool-street Station. That station was partly opened for suburban traffic in 1874, and, according to his lordship, was built on faulty principles, in that it was placed below the street level. The object of so disposing it was the fact that the line had to be crossed by two adjacent thoroughfares; but in Lord Claud's opinion, the difficulties presented could have been overcome by modern engineers. The result of the original mistake has been that every one of the company's trains has to start its journey at the foot of an incline, while, in addition, the travelling public has been greatly inconvenienced.

St. Paul's Bridge.

TOWARDS the end of last week a conference was held at the Ministry of Transport to consider the proposal for the construction of a new bridge across the Thames. The conference was presided over by Colonel Wilfred Ashley, Parliamentary Secretary to to Ministry, and was composed of representatives of the London County Council, the City Corporation and the Metropolitan Boroughs of Southwark, Holborn and Finsbury. It was ultimately decided, after a prolonged discussion, to appoint a small sub-committee, under the chairmanship of Sir Henry Maybury, to go thoroughly into the matter. As has previously been recorded in this Journal, the City Bridge House Estates Committee desires to see the work begun as soon as possible, and is strongly in favour of the bridge being built between the existing Southwark and Blackfriars Bridges, with the northern approach carried over Queen Victoria-street on a viaduct. As such a scheme would necessitate the widening or rearrangement of existing streets, financial and other assistance, it is suggested, might be supplied by the Ministry of Transport instead of falling wholly on the City Corporation. The Ministry, it is understood, views the scheme with favour, and is willing to give it what aid it can. There are still many who would prefer to see London's cross-river traffic facilitated by the removal of Charing Cross railway station to the Surrey side and the erection of a new bridge across the Thames on the site now occupied by the combined railway and Hungerford foot bridges. This scheme was discussed at the Conference, but it would appear that there would be some difficulty in carrying it out by virtue of the fact that the site is outside the City area, so that some doubt exists whether the City authorities would be able to contribute financially to its execution.

A Notable Motor Ship Conversion.

EARLY in the week the ex-German motor ship the Fritz—now the Assyrian of the Ellerman Lines, Limited—arrived at Dundee, where her Diesel machinery will be taken out and replaced by steam machinery constructed by the Dundee firm, Cooper and Greig, Limited. The engines of the Fritz, it may be recalled, were the first double-acting two-cycle Diesel engines which were built for marine service by Blohm and Voss, of Hamburg. Since the handing over of the vessel in accordance with Treaty terms, immediately on the conclusion of the builder's trials, the vessel has been in the service of various British shipping companies. The steam machinery which is to be installed comprises two sets of triple expansion engines and boilers, which are now in course of construction. The work of conversion will occupy about four months.

Locomotives Ordered for India.

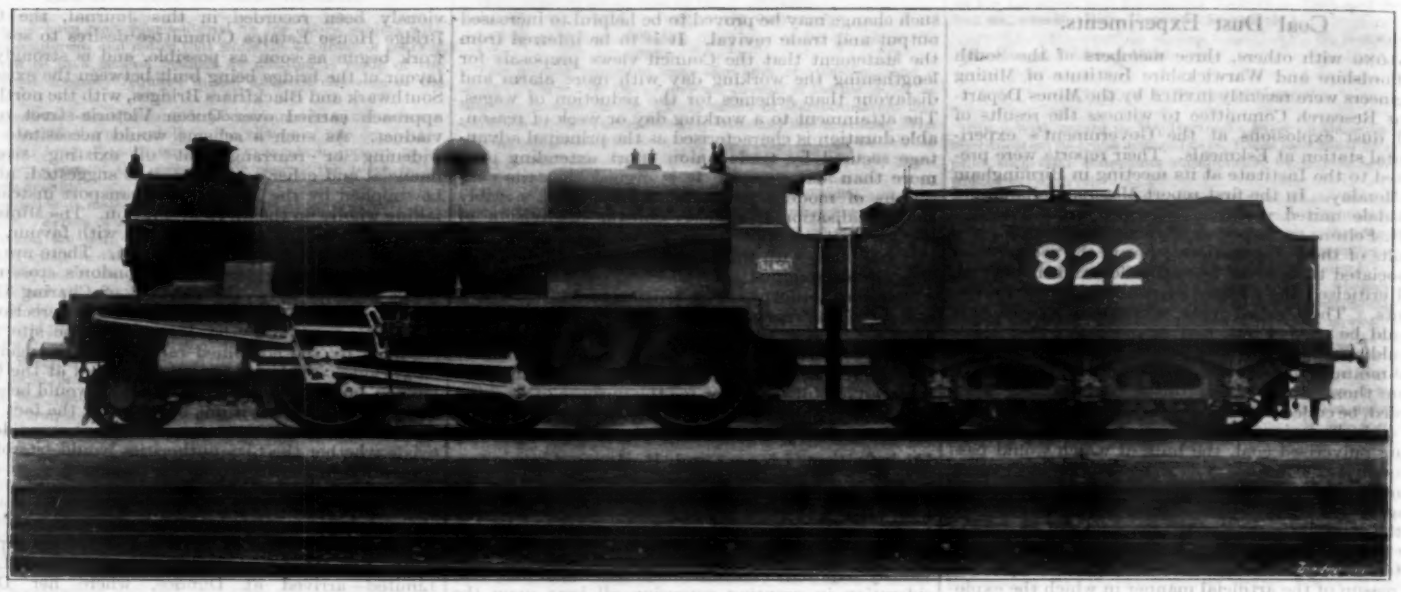
IN the locomotive building industry there are distinct signs of a highly welcome revival of activity. During the period of depression the private builders were very severely hit, for their business has for a long time been preponderatingly conducted with overseas customers, the engines required by the home railways being almost wholly built in their own workshops. The latest orders for railway locomotives placed in this country may not be extensive, but they are none the less gratifying. We have officially confirmed the fact that Armstrong, Whitworth and Co., Limited, have just received an order for twenty engines for the Indian State Railways, and the Vulcan Foundry, of Newton-le-Willows, an order for fifty-five for the same lines.

Sixty Years Ago.

IN 1863 iron shipbuilding on the Thames was in a highly prosperous condition. A note in our issue for February 20th of that year recorded that immense progress had been made by the Thames-side shipbuilding firms during the two preceding years, as a result of "the sensation created by the Merrimac" and the demand created for iron-built naval and sailing vessels. Another reason for the activity was the fact that timber had risen greatly in price, with the result that a large amount of capital was required to keep up a stock of seasoned material. It was added that in wooden shipbuilding there was a great waste of material from cuttings and shipwrights' perquisites, whereas in an iron building yard "every scrap was swept up and run down again for use." Among the yards on the Thames at that date were Barnard's at Deptford, Pitcher's at Northfleet, Wigram's at Blackwall, the Thames Shipbuilding Company's Orchard Yard (formerly Mare's), the Millwall Shipbuilding Company's yard (formerly, in part, Scott Russell's, and in part Mare's), Samuda Brothers in the Isle of Dogs, and the Government yard at Deptford. Among the marine engine builders were Miller and Ravenhill of Lambeth and Rotherhithe, Rennie of Blackfriars, Penn of Greenwich, Stewart of Blackwall, and Dudgeon of unspecified address. At the time some 87,000 tons of iron shipping were under construction on the Thames, and between the yards and the engine shops some 20,000 men were finding employment. It was recorded with satisfaction that, in spite of all this work, there had been no sensible enhancement in the price of metal, although some difficulty was foreseen in the supply of 4½in., 5in. or 5½in. armour plate, by reason of its being a new feature in the trade and because of the uncertainty created in the minds of the ironmasters by rumours that the Government proposed to erect mills for the purpose in the Royal dockyards, and deprive private manufacturers of the business.

SOUTHERN RAILWAY—THREE-CYLINDER SIMPLE SUPERHEATER LOCOMOTIVE

MR. R. E. L. MAUNSELL, M.I. MECH. E., ASHFORD, ENGINEER



Southern Railway (S.E. and C.) Three-cylinder Locomotive.

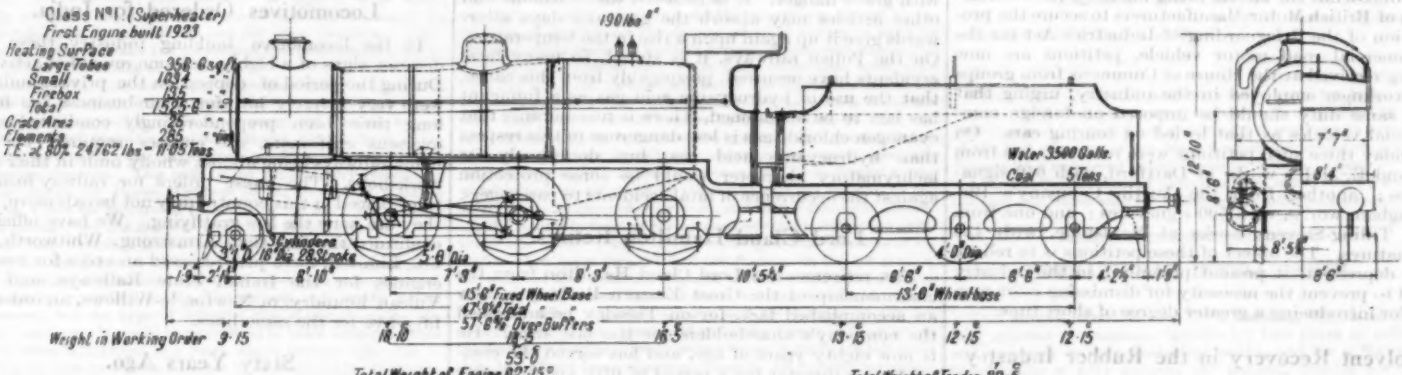
FIFTEEN 2-6-0 locomotives—Nos. 811 to 825—are now being built at Ashford works to the designs of Mr. R. E. L. Maunsell, and of these engines No. 822 has just been turned out as a three-cylinder simple superheater engine. It is illustrated herewith by an outline drawing and half-tone block.

The cylinders, 16in. diameter by 28in. stroke, all drive the middle axle of the coupled wheels. The outside cylinders are horizontal, but the inside cylinder is inclined at 1 in 8 so that the connecting-rod and crosshead may clear the leading coupled axle. The piston valves for all the cylinders are identical, but the outside valves are set above, and the inside valve on the side of their respective cylinders. All the valves are 8in. in diameter. Those on the outside are actuated direct by Walschaerts gear, whilst the inside valve is actuated by a modified Gresley gear, as shown in the diagram above. The difference between this gear and the Great Northern gears is that the motion is taken from each outside pendulum lever to the cross levers instead of from an extension of the front end of the valve spindles. In this way the valves of the outside cylinders are kept horizontal, and any variation due to expansion of the valve spindle or the wear of the link and pins is not transferred to the valve of the middle cylinder. Furthermore, it becomes easy to withdraw all the piston valves and the middle piston without dismantling any of the gear.

The middle cylinder and the left-hand outside cylinder are combined in one casting, and the right-hand cylinder is bolted to them, so as to form the complete unit. Automatic by-pass and water-relief valves are fitted to each cylinder.

The single-throw crank axle is of the built-up type with the sweeps extended so as to form counter-weights which balance the crank pin and part of the connecting-rod. It has thus been possible to retain the same wheel centre castings as those of the existing two-cylinder engines by reducing the original balance weights in such a way as to give the correct angle for the resultant balance. Owing to the inclination of the inside cylinder, the middle crank pin has been set at 113 deg. to the right-hand crank pin, and 127 deg. to the left-hand crank pin. All three connecting-rods are of the same length. The outside big ends are of the plain bushed type, whilst the inside end is of the strap bolt pattern. The reversing shaft is locked by a clutch actuated by a small steam piston working in a cylinder, to which steam is admitted when the engine is running. The crossheads are of the single-bar type, and the motion pins work in bronze bushes with bronze side thrust washers.

The smoke-box, boiler, frames, wheels, coupling rods, cab, brake, and reversing gear, are all practically identical and interchangeable with those of the two-cylinder engines of the same class.



WEIGHT DIAGRAM OF THE THREE-CYLINDER ENGINE

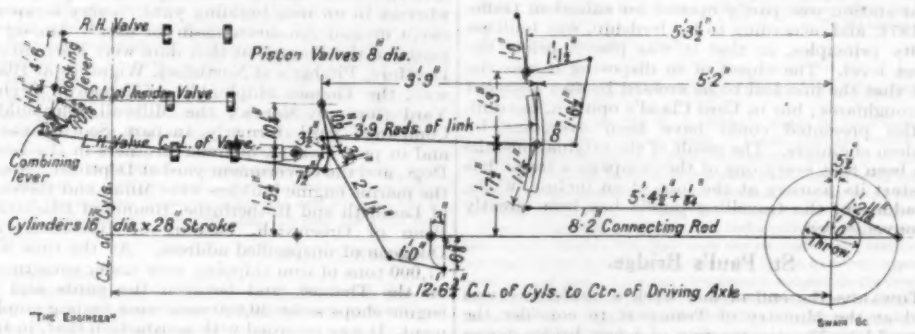


DIAGRAM OF VALVE GEAR

Leading Particulars of Three-cylinder and Two-cylinder Locomotives.

	Three-cylinder.	Two-cylinder.
Boiler—		
Working pressure	190 lb. per sq. in.	200 lb. per sq. in.
Barrel diameter outside front	4ft. 7⅛in. by $^{9}/_{16}$in.	4ft. 7⅛in. by $^{9}/_{16}$in.
Barrel diameter outside fire-box	5ft. 3in. by ⅛in.	5ft. 3in. by ⅛in.
Barrel length	12ft. 6in.	12ft. 6in.
Fire-box shell, width	4ft. 0¼in.	4ft. 0¼in.
Fire-box shell, length	8ft.	8ft.
Tubes, 1¾in. outside diameter	175	175
Tubes, 5½in. outside diameter	21	21
Heating surface:		
Fire-box	135 sq. ft.	135 sq. ft.
Tubes	1390.6 sq. ft.	1390.6 sq. ft.
Total	1525.6 sq. ft.	1525.6 sq. ft.
Superheater—		
21 elements	285 sq. ft. (int.)	285 sq. ft. (int.)
Grate area	25 sq. ft.	25 sq. ft.
Cylinders	Three, 16in. dia. by 28in. stroke	Two, 16in. dia. by 28in. stroke
Piston valves (inside admission)	Three, 8in. dia.	Two, 10in. dia.
Piston valves (maximum travel)	5¾in.	$6^{7}/_{16}$in.
Valve motion	Walschaerts	Walschaerts
Wheels—		
Front bogie (Bissel)	3ft. 1in. dia.	3ft. 1in. dia.
Coupled	5ft. 6in. dia.	5ft. 6in. dia.
Tractive effort at 80 per cent. boiler pressure	11 tons	10.9 tons
Total weight of engine in working order	62 tons 15 cwt.	59 tons 8 cwt.
Total weight on coupled wheels	53 tons	50 tons 18 cwt.
Brake	Steam on engine, vacuum for tender and train	Steam on engine, vacuum for tender and train
Tender, wheels	4ft. dia.	4ft. dia.
Tank capacity—		
Water	3500 gallons	3500 gallons
Coal	5 tons	5 tons

Cylinder lubrication is effected by means of a three-point sight-feed lubricator of Mr. Maunsell's design, having separate condenser, and feeding into the three main steam pipes. The cylinder and steam chest drain cocks are of the mushroom valve type operated by means of small steam pistons, all controlled by one valve conveniently placed just below the hand reverse wheel in the cab. The same valve also controls the reverser clutch referred to. A water sander of the "Lambert" type is used for the leading and driving wheels in forward running. For running backwards dry sand from the tender footplate boxes is used.

The superheater with its header of the Maunsell type, having combined regulator in the smoke-box, with spark-deflecting or diaphragm plates is precisely the same as for the two-cylinder engines. The comparative table of dimensions given shows the difference between the three-cylinder engine and the two-cylinder engine, and it will be noted that in order to make the tractive effort the same in the two engines the boiler pressure of the three-cylinder engine has been reduced to 190 lb. per square inch.

It will be seen that the engine has, as far as possible, been made identical with the two-cylinder engines of the same class at present working on the S.E. and C. section of the Southern Railway, with the object of comparing three-cylinder and two-cylinder simple engines both as regards performance and cost of maintenance.

The British Industries Fair.

No. I.

THE British Industries Fair, which is being held concurrently at Birmingham and Shepherd's Bush from February 19th to March 2nd, is unmistakably, so far as the engineering exhibits are concerned, almost a counterpart of the Fair held twelve months ago. There is, of course, a sprinkling of novelties, while a few of the exhibits of last year that we really expected to see again are absent; but, taken on the whole, there is very little new to chronicle. Although such repetition may be rather disappointing to those in search of novelties, it is, perhaps, satisfactory from a commercial point of view. The representatives of several firms with whom we talked at the Fair, said that they had done good business on the lines of last year's exhibition, and the general tendency seemed to be to make the best of circumstances as they are, rather than incur expenditure on something new. There is, however, the risk—and we heard it referred to at the Exhibition—that if this policy be adhered to too strictly, people may come in from abroad and spoil our markets.

The extent of the midland Exhibition is practically the same as it was a year ago, and it is in the same buildings at the Castle Bromwich aerodrome, near Birmingham. We begin below our description of some of the exhibits.

John Kirkaldy, Limited, of 101, Leadenhall-street, E.C. 3, who were established as long ago as 1809, and have works at Burnt Mill, Essex, where all kinds of marine auxiliary machinery are manufactured, are exhibiting a cold room, about 6ft. by 6ft. by 7ft. high, inside dimensions. It has a substantial framing packed with silicate of cotton, and covered on each side with waterproof lining and matchboards. Galvanised meat rails are provided on the ceiling for quarters of beef, sheep and other large stuff, and wood battens on the walls for smaller joints. The room is cooled by a standard ½-ton CO_2 compressor, which is driven by a 1½ brake horse-power electric motor. The compressed gas passes through coils in the condenser where it is cooled, and from there to the expansion, or regulating valve, and on to the evaporator coils in the brine drum in the room. From the expansion valve the gas passes through a coil in an air duct in the centre of the drum, and thence through a coil in the brine, after which it returns to the machine and is re-compressed and re-cooled. An electrically driven fan is fitted on top of the brine drum which draws the air from the upper part of the room and passes it down the air duct and out through openings at the bottom of the drum. In this way the air is not only cooled, but in its passage down the duct its moisture is extracted and the cooled and dried air freely circulates around the meat. Additional cooling is caused by radiation from the sides of the drum, and the storage of brine keeps the room cold for many hours after the machine is stopped. The machine is operated by only one valve, so that no technical skill is required in working it. Besides the installation just described, there are several other larger refrigerating machines on this stand.

The Tangent Tool and Engineering Company, Limited, of Keynsham, Somerset, has a number of tools embodying the hydraulic principle which we described in connection with this firm's exhibits last year, together with some rotary shears. One of the latter is a rotary shearing machine for trimming the ends of "packs" during the various rolling operations, for use in a tin-plate works. After each pass the "pack" is, of course, folded in halves and the rough ends cut off. The total thickness to be trimmed after each pass is approximately ¼in. The machine is designed to cut at 75ft. per minute, and absorbs approximately 3½ horse-power at this speed. The frame, which is of cast iron, is cored to form a large oil sump. The cutters are 9in. in diameter. The bottom shaft is ring oiled, while the top cutter rotates on its shaft and is lubricated by a Stauffer grease cup. Vertical adjustment of the top cutter is obtained by rotating the shaft, the journal of which is excentric, into the part gripped in the frame. The cutters are sharpened by grinding on their face and the wear taken up by bringing the top cutter forward the necessary amount. The weight of the machine is just under 2 cwt. Another machine shown is a 9in. gap hydraulic riveter, which embodies an adaptation of Smith's single-stroke valveless hydraulic unit. The overall hydraulic and mechanical advantages give approximately 5-tons pressure on the rivet with an ordinary pull on the handle. This load is quite enough to close a ¾in. rivet hot for which the tool was designed. The frame is cast iron, everything else steel, hardened where necessary. Another adaptation of the same type of hydraulic unit, also exhibited, was designed for straightening small crank shafts. The press has a 2in. stroke, and exerts about 3-tons pressure. In a hand-operated hydraulic spring-testing press, also shown by this company, the fluid is pumped from the top portion, which forms a reservoir, to the ram cylinder on the power stroke and returned through a double purpose valve on the upward stroke. The hydraulic advantage is 23 to 1, and the total ram pressure of 20 tons is easily obtained. This is a multi-stroke machine, *i.e.*, one stroke of the plunger does not force the ram the whole 4in., but 20 tons can be exerted through the whole of the 4in. if required. One of the interesting points of this machine is the fact that the ram can be coupled direct to the handle and hence short circuit the hydraulic advantage. This arrangement enables the ram to be raised or lowered its full travel with one pull of the handle. Of course, the only pressure which can be exerted in this case is that obtained by the mechanical average. The press operates as follows:—For bringing the ram rapidly down to the job, the double-purpose valve is opened by a cam, being spring loaded it closes automatically when the cam is released. A pin, which is coupled to the handle by links, is pushed into a jaw machined in the head of the ramrod. This rod is fixed direct to the ram. It is now possible to force the ram down on to the job; the fluid being sucked into the ram cylinder through the double purpose valve. The valve is then closed, the pin released from the jaw in the ramrod, and the pressure is exerted by means of the pump. When the end of the power stroke has been reached the pin is engaged with the ramrod, the double-purpose valve is opened, and the ram withdrawn with a single stroke of the hand lever, the fluid exhausting through this valve into the reservoir. The ramrod passes through the pump plunger and the body. A gland is fitted in the crosshead and a hat leather at the lower end of the body. This leather serves two purposes, for, besides acting as a gland, it is also used as a delivery valve, and so eliminates the orthodox type of valve and cuts down one possible source of trouble. It works and stands up to the load of 2½ tons per square inch quite satisfactorily. The hole through the pump body through which the delivery passes is about $^1/_8$in. larger in diameter than the ramrod.

In another rotary shearing machine, for cutting up to ½in. plates, the frame is of cast steel, and is cored to hold the reduction gear, an oil-tight cover being fitted to the bottom, so that the gears run in oil. The gears themselves are steel castings on hardened steel, the latter, wherever the loads are heavy, of phosphor bronze, and the clutch, normally held in the out position by a spring, is foot-operated. This enables the operator to "inch" a plate if necessary. The top or free cutter shaft is mounted on heavy duty roller bearings to eliminate as much friction and drag as possible. Vertical adjustment of the cutters is obtained by raising or lowering the top cutter, complete in its housing; the side adjustment is obtained by moving the driven cutter complete with its shaft, out or in as necessary, the last gear being mounted on splines to permit this movement. Rollers are arranged so that they are just proud of the frame and carry the load of the plate, thus cutting out any friction that might be caused by the plate rubbing over the bed. In this machine the checks carrying the top cutter have been eliminated, and the frame staggered to enable the plate to pass after shearing. This makes a much cleaner machine and enables partly sheared plates to be readily withdrawn, as there is no obstruction outside the free cutter. Such a procedure was practically impossible with the earlier type of machine, as the deflected sheet fouled the cheeks. During some tests the machine was run up to 23ft. per minute on ½in. plates, the power absorbed being approximately 23 horse-power; but although the machine will stand up to this speed quite satisfactorily, the makers do not recommend any cutting speed over 10ft. per minute. When shearing at 10ft. per minute the machine is under perfect control, the operator being able to start on, and cut to a line, and to stop whenever he wishes. At 10ft. per minute the approximate power required is 10 horse-power.

Holt and Willetts, of Lion Works, Cradley Heath, have an electrically operated hauling winch for dealing with cargo or for shipyard use. It is capable of exerting a pull of 3 tons direct from the drum at a speed of 50ft. per minute. It is coupled directly to a totally enclosed reversing electric motor which is designed to give out 15 brake horse-power at 700 revolutions per minute, and is fitted with the usual pedal-operated brake for rapid lowering, besides an automatic electric brake to hold the load in case of failure or interruption of the supply. On this stand there is also an electric overhead travelling crab for lifting 3 tons at 25ft. per minute and travelling at 75ft. per minute; a hand power overhead travelling crab, to lift 2 tons; and a direct-coupled electric hoisting gear, capable of lifting 1 ton at 100ft. per minute. This gear is suitable for either goods or passenger cage lifts, and made in sizes from 3 cwt. to 30 tons. It is of the worm-gear type, with a machine cut phosphor bronze worm wheel, and a steel worm running in an oil bath in a cast iron case. The thrust of the worm is taken on a ball thrust bearing. There are also a belt-driven hoisting gear, to lift 1 ton at 60ft. to 70ft. per minute; a direct-coupled electric friction hoist, for lifting 5 cwt. at a speed of 75ft. per minute, and sundry other smaller types of lifting tackle.

Venner Time Switches, Limited, of 45, Horseferry-road, Westminster, are showing:—A complete range of time switches, for from 1½ to 400 amperes, single, double, and triple-pole, for all pressures up to 2500 volts, fitted with 1, 14, and 45 day clocks; in wooden, cast iron, and cast aluminium boxes. There are also on this stand some current limiters, aluminium and other non-ferrous castings.

John Thompson Water Tube Boilers, Limited, of Wolverhampton, have a scale model of the familiar dish-ended Lancashire boiler, some superheater units, cross sections through vertical water-tube boilers, and a model Kennicott water softening plant. We heard that this company is at present at work on the construction of a battery of water-tube boilers, for a power-house, which will be capable of evaporating 900,000 lb. of water per hour.

Wm. Kenyon and Sons, Limited, Dukinfield, have the same position as during the last two years, but now have the advantage of a stand with four frontages. On one side there is a representative display of interstranded cotton driving rope and a small scale working model of a cotton mill driven from a Metropolitan-Vickers high-speed geared turbine by means of Kenyon's ropes. In the mechanical section, on the other side of the stand, there is a complete modern ring spinning frame drive, comprising a "Weilding" clutch, such as we described twelve months ago, fitted on a spinning frame end; the "Ruscoe" patented gallows pulley bracket, and lineshaft pulley. There is also a specimen of a special "under-pressure" drilling apparatus, by means of which joints, connections, &c., may be made in a gas or water mains without interference with the flow. The boiler covering and sheet metal work department of this firm is represented by a small scale model of a Lancashire boiler with modern heat insulating coverings shown in section.

The British Mannesmann Tube Company, Limited, of Newport, Mon., has a stand for which an imposing entrance arch has been formed by a large "U" shaped bend, 45ft. 6in. long by 9in. dameter, made in one weldless length flanged at each end. Two ship's davits, each in one piece without weld or joint, and two poles for electric tramway transmission purposes, each made in one single weldless length, stepped in the usual manner, are also grouped near this bend. On the stand there are various types of expansion pipes for steam, some specimens of weldless steel cylinders for compressed air and gases, and a miscellaneous assortment of exhibits, comprising British and American standard flanges, various forgings, rock drills, driving joints, smoke bends, tubes with concrete linings, reducing pieces for gas and water mains, also special fittings for spigot and faucet tubes, such as Y pieces, tee pieces, crosses and bends. There are also some sections of lapwelded steel pipes over 14in. diameter up to 72in. diameter, the manufacture of which has recently been taken up by this company.

Nobel Industries, Limited, of Buckingham-gate, London, S.W. 1, have, besides the explosives and accessories with which this name is generally associated, a number of exhibits of more direct engineering interest. Thus the associated firm of Kynoch, Limited, Birmingham, exhibits power presses at work and articles wholly or partly manufactured with their aid, such as drawn tubes, lamps for motor cars, and other brass and copper hollow ware. Samples of non-ferrous metals in the form of ingots, forgings, castings, strips, sheets, rod, wire, &c., manufactured by Kynoch, Limited, and the King's Norton Metal Company, Limited, included among the exhibits, while Edison accumulators and Newton electric motors—by Rotax, Limited— are also shown, together with other specimens of Nobel's interests in the engineering world, such as the products of Thermit Limited—the rail welders—and carbon free metals and alloys and a powder mixing machine, manufactured by the Continuous Reaction Company, Limited. The exhibit of the products of Necol Industrial Collodions, Limited, include Necol household cement, the plastic wood, to which we have referred in the past; and other applications of this company's products for lacquering metal ware, coating leather, wood finishes, &c.

Oil Engine Nomenclature.*

By J. L. CHALONER.

IN a paper on "High Speed Oil Engines," which was read by Mr. J. L. Chaloner before the Institution of Automobile Engineers in London, on Thursday of last week, the author makes an interesting contribution to the much debated subject of oil engine nomenclature.

It has been suggested, Mr. Chaloner says, that there are too many types of oil engines to permit of a simple classification. He finds, however, that a detailed study of the many designs brings out the fact that they are in almost every case a modification of some fundamental principle or a combination of two or more such principles.

"Otto" has fallen into obscurity, "hot-bulb" requires qualification, "Diesel" is perplexing and inaccurate, "Semi-Diesel" lacks precision, "cold-starting" is misleading, "high-compression" may refer to oil or petrol engines, "crude oil" shows misrepresentation, and "refined oil" confesses a deficiency. Yet all the existing types can be allocated in accordance with definite ranges of pressure—whether compression-pressure or maximum pressure is immaterial—and methods of fuel injection. When including high-speed engines the problems of nomenclature are certainly somewhat more complicated, because there is the tendency of the "constant-volume" and "constant-pressure" cycles to merge into each other.

The above remarks are, he says, considered sufficient reason for including in these notes a suggested system of classification of liquid fuel internal-combustion engines :—

I. *Gas Injection.*—(A) Low-pressure engine : (1) The fuel is mixed with the requisite amount of air in a mixing chamber (carburetter or vaporiser). The mixture is drawn into the cylinder, compressed to a moderately low compression-pressure and fired. (Otto cycle, Clerk cycle.) (B) Medium-pressure engine : (1) No representative type in existence. (C) High-pressure engine : (1) The fuel is pumped into a small passage leading from the cylinder to a vaporiser. The gas pressure produced by a small fraction of the charge in the vaporiser injects the main charge into the combustion chamber. (Deutz system, Steinbecker type, Krupp type.) (2) The fuel is fed or injected into a cup or secondary chamber adjacent to the combustion chamber and connected with it by a series of small holes or channels. The heat of compression ignites the volatile fractions of the fuel and the resultant gas pressure forces the main charge into the combustion chamber. (Brons system, Ellwe system, Hvid type, Sabathé type, Leissner type, Sulzer type.)

II. *Air Injection.*—(A) Low-pressure engine : (1) The compressed air injects the charge during the induction or the first part of the compression stroke. The mixture is compressed to a moderately low compression-pressure and fired. (Bellem et Brégéras system, Egersdörfer type.) (B) Medium-pressure engine : (1) Compressed air injects the charge split up into main and auxiliary spray. The latter passes over a hot surface and meets the main spray in the combustion chamber. (Blackstone system.) (C) High-pressure engine : (1) Compressed air injects the charge towards the end of the compression. The compressed air may be generated by the action of the main piston as distinct from an independent compressor. The fuel charge may be kept separate from the compressed air. (Diesel and Clerk cycle, Trinkler and Haselwarder systems, Körting and M. A. N. types.)

III. *Mechanical Injection.*—(A) Low-pressure engine (1) The charge is injected by pump pressure into the combustion chamber during compression and fired either by electric spark or hot surface. (Priestman system.) (B) Medium-pressure engine : (1) The charge is injected by pump pressure into the combustion chamber at the end of the compression, directed towards a hot surface, which introduces the ignition. (Ackroyd system, Rundlöf type, Crossley type.) (C) High-pressure engine : (1) The charge is injected by pump pressure into the combustion chamber at the end of the compression. The heat of compression ignites the charge. (Vickers, Ruston, Campbell and Doxford systems.)

The above arrangement brings out the simple nature of oil engine classification, which becomes possible by using pressure as the basis, although the variations are numerous and the combinations obscured. "Hornsby-Ackroyd-Otto" and "Trinkler-Haselwarder-Brons-Ellwe" are instances which indicate very forcibly the fallacy of extending the system of descriptive titles.

No practical application, it will be noted, has so far been found for the gas-injection systems of the medium-pressure type. Engineers have, however, recognised the technical difficulties in controlling gas pressures of highly volatile fuels, or in producing adequate gas pressures of the available time of the injection period with fuels comparatively free in volatile constituents. Yet the scope for further development in this direction is not lost sight of, and a partial combination with the mechanical-injection system appears a practical proposition for high-speed engines.

Mr. Chaloner's paper, which is accompanied by full tables giving technical particulars of the principal types of high-speed oil and petrol engines, as well as numerous drawings of constructional parts, forms a concise review of the progress which has been made up to the present time. The problem of internal combustion and the attendant questions of the atomisation and gasification of the fuel charge, are discussed. In the opinion of the author, the engineer will require the close co-operation of the chemical physicist for further work on the more effective utilisation of the available heat energy.

An interesting section of the paper deals with the automobile type of engine, and an account is given of the Peugeot—Tartrais two-stroke heavy oil engine, which has recently completed successful road trials in France.

In summarising his conclusions, the author states that the nomenclature demands revision, because a clear and concise terminology is useful in recognising the technical characteristics of various engines. The classification in accordance with the pressure range suggests a simple system which would be applicable in every sense to the ready identification of internal-combustion engines of all types.

Internal combustion is a phenomenon which, from a technical point of view, is not at present explained in a satisfactory manner. A system which only yields a possible maximum return of 50 per cent. is not comparable with the high standard of efficiency which engineers are endeavouring to obtain and maintain. It is hoped, however, that a closer study of the conditions which help or hinder combustion efficiency will indicate the direction in which lies the further utilisation of the latent properties of liquid fuels. That, together with a possible change in the thermo-dynamical aspect of the problem, should be the means of establishing some new and more efficient cycle for internal combustion.

As regards the present type of oil engine, the limiting values for the leading dimensions appear to be clearly understood. Cylinder dimensions, piston speed and mean effective pressures are all controlled by mechanical and metallurgical limitations.

For high-speed oil engines the cylinder capacity and injection device present the chief difficulties. The larger amount of excess air which is still required for oil engines has brought the two-stroke engine into prominence, but the reduced mean effective pressure for two-stroke engines has to be counted at present as a disadvantage. The importance of suitable materials is self-evident, and the rate of progress will depend to a large degree on the effective co-operation of the engineer and the metallurgist. The dual chamber as a form of cylinder-head construction is established, and the high-speed mechanical-injection pump is represented to-day by several promising examples. The weight/power ratio has already been reduced to commercial figures, and there are, therefore, left only such details as might be considered as problems inherent in internal-combustion engines.

It is not suggested that the change to high-speed oil engines will be anything but gradual. Any system, however, which facilitates or enhances the flexibility of an engine with regard to a wide range of fuel has an industrial and economic value of which advantage will be taken by the automobile and allied industries.

* Extracts from a paper read before the Institution of Automobile Engineers, February 15th, 1923.

New Lighthouse Apparatus for Port Said.

WE were invited earlier in the week to inspect at the works of Chance Brothers and Company, Limited, at Smethwick, a new apparatus which that firm has constructed for the lighthouse at Port Said, and which consists of a lens, with its mercury float pedestal, revolving clockwork mechanism and burners. The lantern, of 12ft. 9in. internal diameter, inside which the apparatus, &c., will be placed, has already been dispatched to Port Said. The installation is to replace an existing light and lantern, which was also supplied by Messrs. Chance

LIGHTHOUSE APPARATUS FOR PORT SAID

in 1902, and consists of a fourth order lens with an electric lamp, the lens having a focus of 250 mm. The new light is of the first order, the lens having a focus of 920 mm.

The illuminant is an incandescent oil burner of the latest type, giving a very high intrinsic brilliancy, and it will replace the existing electric lamp, with, we are informed, a resulting large economy in cost of upkeep and attendance. The beam from the new lens will be about 1,250,000 British candles, which will give a luminous range of between 90 and 100 miles in clear weather in the Mediterranean. The height from the sea-level to the focal plane of the light when erected on the tower will be 184ft., and this will give an actual geographical range to a vessel at sea of 24 miles.

The accompanying engraving shows the new optical apparatus and pedestal. The optical apparatus, which is of the single flashing type, consists of three panels, each covering 120 deg. horizontal angle. The single flash is of 0.56 seconds duration every 10 seconds. The revolving portion of the apparatus weighs 3¼ tons, and is carried on a mercury bath, the weight of the mercury employed being about 450 lb. The apparatus is revolved by clockwork, driven by a falling weight. The "Chance" incandescent oil burner, which is provided, has an autoform mantle of 110 mm.—4.33in. diameter. It works on the vapourised oil system, the oil being stored in containers in the lantern and forced up to the burner by air pressure. The use of autoform mantles instead of the old collodion type is a modern innovation, and results in a great increase of candle-power from the lens, the intrinsic brightness of the mantle itself being about 70 per cent. higher than that given by the old type. Their introduction and adoption in this country has been due to Mr. D. W. Hood, Engineer-in-chief to the Honourable Corporation of Trinity House, who has also designed an autoform type of burner which is in use in the lights under the control of that Corporation. Though burners having this new type of mantle have been installed in various existing lights, this is the first new large light which has been supplied with and specially focussed for it by Messrs. Chance.

The new apparatus was ordered by the Director-General of Ports and Lighthouses Administration to the Egyptian Government. The work has been carried out to the requirements and specification of Mr. Alexander Grafton, Superintendent Engineer of Lighthouses, Alexandria, Egypt, who is also responsible for the erection in Egypt.

AUSTRALIAN ENGINEERING NOTES.

THE new Chief Commissioner of Railways in South Australia (Mr. W. A. Webb), after giving attention to the haulage capacity of the State's locomotives, has written to the leading English, Scottish, Australian and American builders, asking them for suggestions for new types of engines, more particularly of the following classes :—"Mountain" type passenger engines, with tractive effort of 41,000 lb. to 43,000 lb. ; "Pacific" type passenger locomotive, with tractive effort of 32,000 lb. to 35,000 lb. ; "Mikado" type of goods engine, 50,000 lb. to 55,000 lb. ; "Decapod" type of freight engine, 60,000 lb. to 65,000 lb. ; and "Santa Fé" type of engine, 60,000 lb. The most powerful locomotive running in South Australia at present has a tractive effort of 20,000 lb. The Commissioner says that tenders for the proposed new types are not being called at present, but on receipt of suggestions from locomotive builders requests will be placed for definite designs.

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THE Queensland Minister for Mines has announced that it has been decided to close down the State gas and oil bore at Roma. The bore and about 1400ft. of 12¼in. casing will be offered to the Roma Town Council for water supply purposes for £1450. About £35,000 was spent in boring, apart from the outlay on the original bore nearby. The Minister said that it was intended to amend the Mining Act in 1923 with the view of giving greater encouragement to oil development, with due safeguards to the State, and preventing as far as possible any undue speculation in oil.

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A NEW body to incorporate the cotton-growing associations now existing is being floated in Brisbane with a nominal capital of £1,000,000. It will be styled the Australian Cotton Growing Association of Queensland, Limited. The superintendent of the southern division of the Association has stated that sufficient cotton seed has been applied for to sow 140,000 acres in Queensland. The number of gins at Rockhampton and Whinstanes is being increased from three to eight, and thirty-two new installations are in course of construction at various points. An oil mill is to be established at Whinstanes, with a large capacity, which is to be capable of producing 40 gallons of oil to the ton. A 40-ton mill at Rockhampton is also projected. The mills will produce oil cake and olive oil. The brokers of the new concern declare that there does not appear to be any shortage of capital for first-class investments, and British capital is coming forward for investment in cotton and other propositions. The Victorian Ministry has decided to co-operate with the Commonwealth Government in giving a guarantee of 5½d. per pound for seed cotton of 1⅛in. staple and more. Increased production in the State is expected to result from this action.

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THE Victorian Minister for Mines has issued a statement in which he expresses the opinion that the outlook for gold mining in Victoria for the year 1923 is distinctly bright. He points out that new companies have been formed for the purpose of reopening old mines in districts where mining has been under a cloud in recent years, and some of these have applied for assistance under the provisions of the Mining Development Act. The New Langi Logan Company has been advanced £3500 under this Act, and endeavours are being made around Walhalla—the scene of very rich yields in the past—to pick up the continuation of an earlier rich reef. The Hobart *Mercury* states that consequent upon a recent discovery of a zinc-blende ore body at Comstock, a number of applications are being made for tribute rights on mining sections there. If a favourable tariff is forthcoming for the ore, there should be considerable activity in the district.

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PRELIMINARY steps have been taken in Brisbane to give effect to the provisions of the Irrigation Act of 1922, which provides for carrying out what is known briefly as the Dawson Valley irrigation scheme, an undertaking estimated to cost several million pounds. It is likely that cotton will be grown on the irrigated area.

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THE Queensland Minister for Mines reports that the silver-lead furnaces at the State mines at Chillagoe are running continuously, and are producing approximately £1000 worth of metal daily. The smelters are shipping between 500 and 600 tons a month from Cairns direct to London. Copper is not being smelted, but as supplies accumulate it may be decided to have a run of four months on copper.

Railway Matters.

IT was stated at the final meeting of the London and South-Western Railway that the cost of the reconstruction of Waterloo station had been £2,270,000.

THE reconstruction of Bangor station and yard, referred to in our annual article on January 12th, has been begun by the demolition of the carriage shed on the north side of the Carnarvon Bay line.

DURING the four weeks ended December 2nd the Great Western Railway ran 120,723 trains, of which the average number of minutes' late arrival was three. It will be remembered that there were several days when local fog prevailed.

THE month of November last, when compared with the same period of 1921, showed an increase of 83.1 per cent. in the tonnage of ironstone and iron ore conveyed, of 60.5 per cent. of limestone, of 61.6 per cent. of pig iron, and of 33.6 per cent. of iron and steel.

THE Welsh Highland Light Railways would appear to be making progress. They have now received from the Ministry of Transport an Order authorising the construction of deviation railways in substitution of some contemplated under the Order of last year.

THREE of the gentlemen whose names appeared in the second list of New Year Honours are railway directors. Sir George Younger and Sir Owen Philipps are directors of the Southern Railway and Mr. Joseph H. Kaye a director of the London, Midland and Scottish.

AT the final meeting of the Maryport and Carlisle Railway Company—now absorbed in the London, Midland and Scottish—the chairman said that it was the senior British railway. It was built in 1835, and finished as it was originally planned and constructed. All other British railways, of equal age, had been built up by numerous amalgamations.

THE report of Lieut.-Colonel Mount, issued on the 15th inst., on the collision of December 6th at Birkenhead Park station, shows that the driver of the Wirral up train passed the outer and inner home signals at "danger." Some severe comments are made on the inattention of the fireman and guard. The latter saw the signals at "danger" but took no steps to stop the train.

THE collision on December 18th at Abbey Gates signal-box, between Canning Town and Stratford Market, when a Great Eastern passenger train ran into a London and North-Western goods train, is stated in Colonel Mount's report, recently issued, to have been due to the driver of the passenger train failing to notice the condition of the starting signal. The man had been checked at the home signal and should, therefore, have been prepared, as laid down in rule 40 (*a*) to find the starting signal at "danger."

A TELEGRAM to the *Times* says that it was reported on the Dublin Stock Exchange, on the 15th inst., that arrangements had been completed for the amalgamation of the Great Northern and the Midland Great Western companies. We hope that this is so. The two companies meet at Wavan and Cavan, and do not compete at any other point. Such an amalgamation would be a source of strength to the private ownership of the railways in the Free State at a time when their existence is threatened.

THE Ministry of Transport inquiry into the collision at Retford on the 13th inst. was held by Colonel Pringle on Friday last. The evidence showed that the signals at the two boxes—Canal box and Babworth, in the rear of Retford North box, where the goods train was shunting—were against the express. There was some fog, but the evidence was contradictory as to whether the fogsignalmen should not have been out. Until the adjourned coroner's inquest has been held on Monday next, it is better to say nothing more.

THE Gwendreath Valley Railway is, according to the *Great Western Railway Magazine*, the smallest undertaking absorbed by the Great Western Company under the Railways Act. It extended from a junction with the Great Western Railway at Kidwelly and one with the Barry Port Railway to Mynydd-y-garreg, 3 miles distant, where were extensive lime works. It had two tank engines, 19 open wagons, and 10 covered wagons. Extensive deposits of silica stone are also found at Mynydd-y-garreg, of which fire-bricks are made. There are some interesting tin-works, whose history goes back earlier than 1781, wherein is a tablet, "These tin-works, the oldest in the kingdom, were rebuilt by Haselwood Hathaway and Perkins, A.D. 1801."

IN the report of the Midland Railway the directors stated that conditions gradually improved in the year 1922, and with reviving trade and a return to the pre-war efficiency in the movement of traffic, they are of the opinion that a further reduction in rates will be justified at an early date, and discussions to this end have already taken place. The directors of the London and North-Western Railway in their report refer to the subject in the following terms:—Your directors are of opinion, having regard to the working for the past year, and with a view to doing their share towards promoting the interests of the country, that the time has arrived when a further substantial reduction in rates, &c., should now be considered by the boards of the new group companies.

ACCORDING to the Board of Trade returns the value of the railway material exported during the twelve months ended December 31st last was as follows, the corresponding figures for 1921 and 1920 being added in brackets: Locomotives, £5,074,843 (£7,936,903, £5,987,394); rails, £2,475,933 (£3,101, 280, £2,698,190); carriages, £2.016,492 (£1,567,978, £1,695,007); wagons, £3,330,924 (£6,023,516, £5,709,711); wheels and axles, £110,6532 (£1,727,033, £1,925,007); tires and axles, £417,082 (£1,297,700, £1,417,203); chairs and metal sleepers, £2,016,287, (£1,523,580, £1,315,802); miscellaneous permanent way, £1,389,273 (£2,857,800, £2,368,785); total permanent way, £7,688,428 (£10,571,882, £9,947,168). The weight of the rails exported was 255,770 tons (176,381 tons, 113,079 tons), and of the chairs and metal sleepers, 143,066 tons (68,561 tons, 60,684 tons). Locomotives to the value of £159,046 were shipped to India during December, and during the same month rails to the value of £52,244 to Australia, and £46,280 to India.

Notes and Memoranda.

IT is reported from Ottawa that Professor J. C. McLennan has succeeded in liquefying helium. This is said to be the first time that helium has been liquefied outside Holland, where Dr. K. Onnes liquefied it in 1908.

ACCORDING to the Federal Bureau of Statistics pig iron production in Canada during December, 1922, amounted to 35,891 tons, as compared with 34,280 tons in the preceding month, an increase of 4.7 per cent. The total production of pig iron in 1922 was 383,057 tons, as compared with an output of 594,354 tons in the previous year. The number of blast-furnaces remained unchanged during December—two at Sydney, one at Hamilton, and one at Sault Ste. Marie.

A NEW and improved method of making a superior grade of purified carbon at moderate cost has been recently invented by Professor Victor Lenher, of the chemistry department of the University of Wisconsin, and patented jointly with the General Electric Company. The new process consists of treating charcoal with selenium oxychloride, a solvent for the hydrocarbons, removing the solution, and washing the residue. The product of such a treatment is much purer than the product of other methods, it is said, and possesses great absorptive properties, and may be used more effectively than ordinary activated charcoal for the absorption of gases. Relatively moderate temperatures below 100 deg. Cent. are used.

IN his report on the commercial, industrial and economic situation of China, to the Department of Overseas Trade, dated July, 1922, Mr. H. H. Fox, Commercial Counsellor to the British Legation, Peking, remarks that an estimate of the production of coal in China for the year 1920 was given in last year's report, showing a possible output of some 20,000,000 tons, of which nearly 13,000,000 tons were produced by the larger mines worked on modern lines. More recent estimates of the annual production made by various experts show figures ranging between 10 and 18 million tons. The country's coal reserves are said to be probably between 40 and 50 milliards of tons. While these reserves are very considerable when compared with the present consumption per head of the population, they would, of course, be small if the consumption were on a level with that of the people of Great Britain or America. According to China's leading mineral expert, the proportion of anthracite to bituminous coal is greater than 1 : 3, while that for the world generally is 1 : 8.

THE lot of the supply engineer who possesses a direct-current network, states the *Electrician*, is at present unenviable. To meet not only a growing domestic load, but the ordinary expansion of his undertaking, he is faced with a heavy capital expenditure on mains and sub-station plant and with considerable money charges attendant upon the operation of the latter. In certain cases, as at Newcastle, this problem has been tackled by boldly changing blocks of consumers over to "alternating," but, apart from the obvious limitations of this course, it is almost impossible where the power load is large and traction has to be considered. The remaining alternatives are to strengthen the feeders from the existing sub-stations, to build new manually-operated sub-stations, to employ mercury rectifiers, or to go in for what are conveniently called automatic sub-stations. The third of these alternatives has found some acceptance in this country, while the fourth, though widely used in America, has, at present, the Walton sub-station of the Liverpool Corporation as its only example in the British Isles.

BEFORE the Chelmsford Engineering Society, Mr. W. H. Patchell recently delivered a lecture on "The Development of Large Power Stations." The author described the electric supply system of the city of Detroit and the surrounding district, which is one of the largest and most highly developed systems in existence. The area covered is 730 square miles and the Electric Supply Company generates 4,000,000 kilowatt hours daily. In Detroit electricity is used much more extensively than in this country. In Glasgow the consumption per head of population per annum is 187 kilowatt-hours, whereas in Detroit this figure stands as high as 630 kilowatt-hours. This has been achieved largely by propaganda work on the part of the company, which has large show rooms, where every sort of electrical appliance is displayed. The tendency at Detroit is to use very large units, the latest sets laid down being 45,000-kilowatt single-spindle machines. The voltage for general use is 110, though for transmission over long distances, pressures up to 48,000 volts are in use, and a line is now under construction to carry 100,000 volts. There seem to be no regulations in America to safeguard the public when high tension lines are used.

WRITING recently in the *Commonwealth Engineer*, Mr. R. Cecil Greasley, of Albury (N.S.W.), described the advantages which have accrued from the combination of the water and electricity supply services in his town. He states that the use of electricity for purposes other than lighting is handicapped by the high rates for energy which are necessitated by the time a plant is not fully loaded, although running. It was found that when the demand for electricity by the town was at a minimum the quantity of water required was greatest, *i.e.*, in summer. As regards daily operation, the municipality is able to pump sufficient water during the period from 1 a.m. to 6 or 8 a.m. to last for the day in winter. In the spring and autumn slack periods come from 5 to 7 p.m., and the increased demand for water can be met during this period. In summer, pumping can be continued from midnight to 6 or 7 p.m., being cut out only for the lighting peak. The pumps can often be run through the week-end. Where, as in Albury, the power and pumping stations are situated together, the town water can be pumped through surface condensers, which means that the electricity department is actually being paid for pumping its circulating water during much of the time it is operating. When the town supply pump is not in operation, water can be pumped for the condensers by means of an auxiliary pump and delivered to settling tanks or returned to the river. During the year 1921 the cost per kilowatt hour sold was 1.995d.; without the pumping load it would have been 2.45d. The charge to the water department was 2d. per kilowatt hour. The system has shown a profit and has enabled prices to be reduced considerably.

Miscellanea.

THERE is a large radium content in the uranium ore found at Jachymov, in Bohemia, near the frontiers of Saxony. Although the radium production in the United States is greater as to quantity, the ores of Jachymov are richer in quality. According to a report by the United States Trade Commissioner at Prague, the known supply of radium in the Jachymov district will last for twenty years at the present rate of production. As there are three large mines which are not yet prospected as to depth, and in which the veins of ore widen as they are followed deeper, it is certain, he says, that the mining of radium will continue far much more than twenty years at Jachymov.

THE Ministry of Transport has recently had under review the tar specifications for surface tarring and for making tar-macadam. As a result, the official publication entitled "General Directions and Specifications relating to the Tar Treatment of Roads," has been re-cast, in consultation with representatives of the interests concerned. The specifications for Tar No. 1 and Tar No. 2 have been revised, and the methods of testing, in so far as they depart from ordinary analytical practice, have been laid down. The revised edition of the "General Directions and Specifications" has now been published, and can be purchased from H.M. Stationery Office or through any of the usual agents.

IN the course of his presidential address at the annual meeting on February 6th of the Institution of Heating and Ventilating Engineers, Mr. John Watson spoke of the progress made during the Institution's twenty-five years of existence. He urged members to continue to support the Research Committee, which was performing valuable service. He also referred to the joint meeting with the Institution of Electrical Engineers, when proposals to use the waste heat of large generating stations, and so make them heating and power stations, were discussed. Professor W. E. Garner read a paper on the combustion of fuel in boiler furnaces, showing how empirical methods were being replaced by scientific control.

ACCORDING to a report by the United States Trade Commissioner at Johannesburg, a new petrol substitute has been invented by a resident of Edenburg, in the Orange Free State. The formula for this new product is a secret, but it is made from the juice of the prickly pear mixed with other chemicals. According to press reports, the spirit has been severely tested on various makes of cars, and is highly recommended, being non-corrosive, odourless and equal to or better than petrol in power and flexibility, a mileage of 22.4 being obtained in a six-cylinder car. It has also been tested by farmers for both tractors and cars, and it is stated that no difference could be detected between running on petrol and on the new fuel. No special carburetter adjustments are necessary.

THE British Commercial Agent for the Netherlands East Indies has forwarded to the Department of Overseas Trade a review of the general commercial activity of Djokjakarta, or Djokja, the sixth largest town in Java. He says that in machinery and accessories the principal requirements are sugar machinery, rice mills, electrical goods, boilers, pumps, water pipes and fittings, agricultural implements and hand tools, and chemical manures, principally ammonium sulphate. The trade is shared by the United Kingdom, Germany, Holland and the United States, and there is nothing to indicate that any one of the competing countries has established a monopoly. In the last twelve months, Germany has obtained a strong hold on the accessories trade, in particular water pipes and fittings, and hand tools.

THE Board of Trade desires to draw the attention of British traders to the fact that, in virtue of recent measures taken by the French and Belgian Governments, the control of the importation and exportation of goods by firms situate or established both in the former occupied territory of Germany and in the Ruhr, and the power of fixing the conditions under which import and export licences may be granted, is now vested in a Special Allied Committee. The German Government has, however, refused to recognise the validity of any licences issued by the Allied authorities in the occupied territory since January 23rd for importation into, or exportation from, the Ruhr or the former occupied territory. Goods so licensed should, therefore, not be forwarded by any route which involves transit through German territory not occupied by the Allies.

IN the course of his annual report, Mr. William Kelso, chief sanitary inspector at Paisley, says that after having had a complete year's working experience of the two 2-ton electric vehicles, it can be stated with every confidence that they have given excellent results. Out of 306 working days, one of the vehicles worked 299 days and the other one 284 days. The time they were out of service was due to wear or breakage of certain working parts, and but for the delay in getting renewals of the parts required, the time lost need not have been more than half what it was. In any case it compares favourably with the time lost by horses from various causes. The most recent calculation shows that, allowing for all capital charges and working costs, they are collecting the refuse 2s. 1d. per ton cheaper than by horse haulage. As they collected 4984 tons during the year, this is equal to a saving of £519 3s. 4d.

IN a lecture on "Electrical Furnaces and Their Uses," recently delivered before the Royal Society of Arts, Mr. C. R. Darling referred to the continually extending application of the electrical resistance furnace and discussed its advantages, which included a small escape of heat, a clean atmosphere, the accuracy and ease with which it could be controlled so as to maintain steady temperature, and the fact that skilled labour was not necessary. Owing to the amount of heat which escaped being small an enclosure could be heated more economically by electricity than by gas, although the cost of 1 therm produced by electricity at 1d. per kilowatt-hour was three times as great as that involved by burning gas at 10d. per therm. When the enclosure was large enough to allow of the gas being burned internally, so that the exterior might be lagged, the thermal costs might then be in favour of gas, but the impurities in the gas often made internal firing objectionable.

HEATING AND LIGHTING EQUIPMENT AT PRESTWOOD SANATORIUM

MESSRS. HENRY LEA AND SON, BIRMINGHAM, ENGINEERS

(For description see page 212)

FIG. 1—TURBINE AND GENERATOR

FIG. 2—OIL ENGINE ROOM AND SWITCHBOARD

FIG. 3—BOILER HOUSE SHOWING BOILER AND ELECTRIC CALORIFIERS

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THE ENGINEER.

FEBRUARY 23, 1923.

Engineers and the Rubber Industry.

WITH the output of the rubber plantations subjected to drastic voluntary restrictions and the manufacturing side faced with immense stocks acquired at high prices, Mr. H. C. Young's paper read before the Mechanical Engineers last Friday deserves the closest attention of all interested technically or otherwise in the rubber industry. Mr. Young's paper was devoted to a consideration of some of the mechanical and electrical problems which arise in the manufacture of rubber products, and contained a wealth of interesting matter which must have surprised, and in fact which we know did surprise, those of his audience who previously had not made an intimate study of the processes followed and the machines used in working up raw rubber into finished articles for the world's markets. Apart from its details, however, it was highly interesting and instructive in the frank revelation which it made regarding the general conditions prevailing in the industry. Mr. Young, as an engineer employed in a rubber factory, appears to have had exceptional opportunities for examining and testing the plant and machinery under his charge. That he has been allowed to describe and criticise what he found is highly commendable, for it is in very sharp contrast to the secrecy with which the technicalities of the rubber industry have previously, and in most quarters still are, hedged around. He found much with which to be dissatisfied, much in which he could effect improvement, as the reader will be able to gather, even from the abbreviated version of the paper which we reprint elsewhere in this issue. It is easier for a camel to pass through the needle's eye than for an outside engineer to enter a rubber factory. Indeed, it is on record that in many of these works those employed in one department are forbidden to visit any other, the restriction applying not only to the operatives, but to the foremen and departmental managers. No doubt much of the secrecy is dictated, rightly or wrongly, by chemical considerations, an aspect upon which, very noticeably, Mr. Young scarcely touched. Nevertheless, we feel grateful to those concerned that he should have been allowed to disclose publicly the mechanical and electrical features of present-day rubber machinery practice, and to suggest freely how that practice might be improved. We sincerely trust that the excellent example thus afforded will be copied by others, for we are certain that it will greatly benefit, not only engineers, but still more the rubber industry itself.

The rubber industry in nearly every one of its aspects is quite an exceptional one, as is to be expected from the fact that rubber itself is in its individual and collective properties a most unusual, if not a unique material. Not only is it the basis of a thousand and one forms of product of distinctive character, but it is manufactured into these products in a variety of fundamentally different ways. It is evident, then, that so long as knowledge concerning its manufacture is confined to the manufacturers, development in its application will rest almost solely with them. We believe it is true that even those engineers who supply the industry with its machines are denied at present in many instances suitable opportunity for studying them after they have been installed in the factories, and that any improvements that are effected in the plant are either carried out by the rubber factories themselves or are communicated to the machinery makers with considerable reluctance. That the result is, in the end, bad for the industry and bad for those using its products can hardly be disputed. In Mr. Young's paper there is hardly a machine or appliance mentioned which is not adversely criticised, in which some reasonable improvement cannot be suggested. That such should be the case is not, in our judgment, any reflection on rubber machinery makers, but is primarily the result of the policy of secrecy which has been followed in the past, a policy which has had the effect of excluding engineers from the factories, or, if admitted, of preventing them from giving free scope to their ability to carry out improvements. The engineer is interested in the matter in another way, namely, as a user or possible user of rubber in its various forms. At the present moment, it is recorded, from 75 to 80 per cent. of the world's output of raw rubber is absorbed by the tire industry. The remainder is used in the manufacture of an amazing variety of smaller articles of secondary importance. As an engineering material, rubber plays, apart from its use in tires, a very insignificant *rôle*. Manufacturers are, no doubt, desirous of widening the field of its application, and, with Mr. Young, we believe that a very considerable extension is possible within the field of engineering. That it will take place is, however, another matter, for under present conditions the ability to suggest new applications rests almost entirely with the manufacturers—who are not engineers—and is largely absent among engineers—who have been denied opportunity for intimately studying the intricacies of rubber manufacture. The engineer is no doubt familiar with rubber as received from the factories, and judges it in the form submitted to him. But is he aware that that form and the properties accompanying it are wholly the result of the manufacturing processes to which it has been subjected, that by suitable modifications of these processes it may be given entirely different properties? Most of the materials with which he works are simple compared with rubber, and he is apt to judge its properties by theirs. If the engineering uses of rubber are to be extended, the engineer must be educated in its manufacture and told how its properties may be controlled over an unprecedentedly wide range by suitable treatment. To take a case in point. Quite recently rubber in tension has been discarded as a means of securing resiliency in aeroplane undercarriages, for it has been found that under tensile stress it deteriorates in exposed situations. Improvement has been effected by redesigning the parts in such a way that the rubber used is wholly under compression, while, going still farther, some designers have now eliminated rubber altogether from their undercarriages. We do not suggest that this elimination of rubber in aeroplane construction, even though it becomes universally adopted, will affect the prosperity of the rubber industry. It is, however, desirable to emphasise the broader issues of the matter, namely, that in this purely structural use of rubber it has been pronounced defective, and that the judgment will probably stand in the way of all other possible applications of the material under tension. Yet is the opinion formed sound? There can be no doubt that the particular rubber or rubbers used have not been satisfactory, but it is far indeed from certain that the condemnation applied to them is of general applicability, for rubber is really a term covering many distinct substances from the physical and chemical point of view. It is not like steel, a material of fairly uniform properties, which may be varied through a limited range by certain understood treatments. Yet under present conditions the engineer is compelled to use it as he would use steel if its composition and mode of manufacture were withheld from his knowledge and its heat treatment were excluded from his control.

So long as the rubber manufacturers insist upon preserving their policy of secrecy, so long, it seems to us, will the material be regarded by engineers

with something akin to distrust. On the other hand, granted a full knowledge of the processes of manufacture, engineers, it is certain, could not only suggest and carry out improvements in these processes leading to economy and an improved quality of product, but could greatly develop the applications of the material in their own work and take full advantage of one of the most curious and potentially useful substances which have been placed at our disposal.

Turbo Generators.

ALTHOUGH many difficult problems presented themselves in connection with the evolution of the steam turbine, perhaps even more troublesome tasks have had to be grappled with in the development of high-speed electric generators. Even to this day, the direct-coupled turbo continuous-current machine is not considered a success, and in those comparatively rare cases in which continuous current has to be generated by turbines, it is now usual to reduce the speed by means of gearing. The difficulties associated with high-speed alternators have, however, been overcome, but only after much experimental work and investigation. It was soon found when attempts were made to run alternating-current generators at turbine speeds that on account of the relatively small volume of these machines, special precautions were necessary to provide adequate ventilation and to avoid damage to the windings at times of heavy overloads and short-circuits. Other troubles were, of course, met with, such as the difficulties of effectively holding the rotor coils against centrifugal forces and the increased risk of fire. It may, in fact, be said that nothing in the history of electrical engineering has called for greater perseverance and skill than the demand for electric generators suitable for coupling to steam turbines.

Reference to papers read in the past before the Institution of Electrical Engineers will show how, from time to time, improvements have been made in the construction of these electric generators, and how increased reliability has been secured, notwithstanding the steady increase in the speed of high-power machines. To this list of papers, written by well-known electrical designers—such as Professor Miles Walker, Mr. M. B. Field, Mr. G. A. Jublin, and others—another has just been added by Mr. J. Rosen, of C. A. Parsons and Co., Limited. Although there is information in this paper which is not new to those who are connected with work of this kind, the author has done useful service in bringing together matter which has hitherto been scattered in various publications and in presenting certain facts concerning difficulties which have been met with and overcome within recent times. From the brief abstract which we publish on another page, it will be perceived, for instance, that it is apparently only recently that voltages induced in the rotor body of high-speed alternators have reached a sufficiently high value to set up arcing. Signs of arcing have been found, among other places, between adjacent sections of keys used for securing the winding coils in the slots, but the trouble has been eliminated by the use of metal bonding strips fitted under the keys. Another part of the paper, which is notable from the point of view of originality, is that which deals with the experiments which were carried out at the Heaton works in 1921, in order to determine the deformation of rotor caps, the excentricity of the cap being obtained by photographing the length of an electric spark jumping across the gap between a fixed contact and the cap. This is quite an ingenious idea which may obviously be adopted in connection with other investigations of a similar kind. The author is also to be congratulated upon his explanation of the reasons for the instability of alternator exciters, a matter, we venture to suggest, which has been none too well understood in the past. The sections of the paper on stator windings and insulation, stator slots, ventilation and water-cooling cover the latest Parsons practice, some of which, we think, must now be familiar to many engineers. The Parsons water-cooled rotor and the parallel air circuit system of ventilation, for example, have been described in THE ENGINEER. Concerning the question of cleaning the air used for ventilation, there seems to be no doubt that the practice of using filters for this purpose is steadily losing favour. The closed circuit system of ventilation in which the same air is repeatedly circulated and cooled in a cooler, which does not bring the water into direct contact with the air, undoubtedly has much to recommend it. Among the advantages of the system is that it is generally possible for the cooler to be installed inside the alternator foundation block. Moreover, as the actual weight of air available to feed an internal fire in the machine is small, the fire risk is reduced. The author's policy of using a separately driven ventilating fan, on the grounds that it is impracticable to construct a highly efficient fan for fitting to the rotor, will not, however, meet with universal approval. There are already many auxiliaries in the modern power-house, and the practice of adding to them should be minimised as far as possible. Nor do we think that the water-cooled rotor is likely to meet with widespread use. Water cooling is, of course, very far from a new idea. It was first applied by Sir Charles Parsons to the stator of an alternator in 1904, and although the scheme has since often been discussed, there seems to be no very marked tendency on the part of central station engineers to depart from the use of air, save under exceptional circumstances.

In the design of high-speed alternators, great progress has been made within recent years. As is shown by the marked diminution in the number of breakdowns, very great care has been taken to localise the true causes of troubles and to apply suitable remedies. What the next step in the development of these machines will be, it is difficult to say. Possibly, however, there will be progress in time to come in the direction of raising the terminal voltage. In this country, the working pressure of alternators is usually about 6600 volts, but, as Mr. H. M. Selvey pointed out in the discussion, alternators are running in Italy at 30,000 volts, which means, of course, that if transmission pressures higher than this value are unnecessary, step-up transformers need not be employed. There are few British engineers, we imagine, who would be prepared to install such high voltage machines at present, but as the machines in Italy apparently work without trouble, the possibility of using higher voltage alternators in this country should not be ignored. The comparatively low currents that would flow to the alternator windings, cables and switchgear would offer distinct advantages, and whilst the static transformer is not an extremely costly or complicated affair, its abolition would, nevertheless, be a step in the direction of simplifying and perhaps to some extent cheapening the power-house equipment.

A Great Gift.

WE print below a letter, written on the sixth of the month, in which Sir Alfred Yarrow offers to give the Royal Society a sum of one hundred thousand pounds for the encouragement of scientific research. The offer has, of course, been accepted. The terms under which this magnificent gift is made are characteristic of the donor. Others might have specified how and in what manner the money was to be employed, and have hedged their munificence about with restrictions. Not so Sir Alfred Yarrow. With a fine foresight and an admirable trust in the wisdom of men of science, he gives this great sum to the Royal Society to deal with as it will, under the sole condition that it shall be expended upon scientific research. "I desire," he writes, "to mark my sense of the value of research to the community by offering, as a gift to the Royal Society, £100,000, to be used as capital or income for the purposes of the Society, as the Council may think fit, because I recognise that conditions alter so materially from time to time that in order to obtain the greatest possible benefit from such a fund, it must be administered with unfettered discretion by the best people from time to time available." These, and these only, are the terms. Sir Alfred, indeed, suggests that the administration of the gift should be reconsidered every ten years, and he adds that he would prefer "that the money be used to aid scientific workers by adequate payment and by the supply of apparatus or other facilities," than that it should be spent on costly buildings, but he concludes: "Although I thus give a general expression of my wishes, I do not intend, by so doing, to create any trust or legal obligation for their fulfilment." We doubt if the Royal Society or any other similar body in the world has ever received a donation, of anything like the value of Sir Alfred's, under conditions so completely devoid of restrictions. This great sum is a "gift" in the most liberal meaning of that word.

Sir Alfred has always been a great giver, not only to science, but to charitable institutions, of which the best known is his convalescent home at Broadstairs. In the realm of science, the model tank at the National Physical Laboratory stands out, but we may recall that only recently he showed the breadth of his interests by founding at Cambridge a studentship in Assyriology in memory of the son he lost in the war. A practical researcher himself, we have no more confirmed believer in the value of research, and particularly of research which can be directed to "practical affairs." "I should like to record," he says, in concluding his letter to the President of the Royal Society, "my firm conviction that a patriotic citizen cannot give money or leave it at his death to better advantage than towards the development of science, upon which the industrial success of the country so largely depends." We observe that Sir Alfred has some fear that gifts to researchers made from his fund may lessen Government grants. We sincerely hope there may never be any real danger of such a consequence. The frequent practice now is that the Department of Scientific and Industrial Research gives the same amount as that subscribed in other ways, and it is reasonable to hope that that policy may be followed in all allocations from the Yarrow Fund. If the Government lacks money, we commend to its attention a paragraph in Wednesday's papers in which it was announced that when Carpentier and Siki meet once more in the ring, ninety per cent. of the receipts are to be devoted to the French Government laboratories for scientific research. How admirable would be an extension of that method of raising money for the progress of British Science.

To the President of the Royal Society.

MY DEAR PRESIDENT,—I would ask you to be so kind as to bring before the Council, at an early opportunity, the following proposals:—

I have for many years held the view that the prosperity of this country has been greatly hampered in the past for the want of better promotion of scientific investigation and its application to practical affairs.

I am convinced that the future prosperity of this country will be largely dependent upon the encouragement of original scientific research.

The birth of new industries, and the development of existing ones, are due largely to the growth of science, thus securing employment and the welfare of the whole community being advanced.

It is doubtful whether even yet it has been realised how completely this country would have been at the mercy of our antagonists in the late war had it not been for the research work done by our scientific men before the war and during its course.

I desire to mark my sense of the value of research to the community by offering, as a gift to the Royal Society, £100,000, to be used as capital or income for the purposes of the Society, as the Council may think fit, because I recognise conditions alter so materially from time to time that, in order to secure the greatest possible benefit from such a fund, it must be administered with unfettered discretion by the best people from time to time available.

Care must, of course, be taken that a gift from the fund shall in no case lessen any Government grant.

In accordance with your practice, you would, I assume, appoint a committee to administer the fund, and would also frame rules for the guidance of the committee while reserving the right to alter such rules from time to time; and I would suggest that they be reconsidered by the Council every tenth year, so as to meet modern needs.

I should prefer that the money be used to aid scientific workers by adequate payment and by the supply of apparatus or other facilities, rather than to erect costly buildings, because large sums of money are sometimes spent on buildings without adequate endowment, and the investigators are embarrassed by financial anxieties.

Although I thus give a general expression of my wishes, I do not intend by so doing to create any trust or legal obligation for their fulfilment.

In conclusion, I should like to record my firm conviction that a patriotic citizen cannot give money, or leave it at his death, to better advantage than towards the development of science, upon which the industrial success of the country so largely depends.—I remain, my dear President, Yours respectfully,

(Signed) A. F. YARROW.

Institution of Mechanical Engineers.

ANNUAL REPORT AND RUBBER MACHINERY.

THE Institution of Mechanical Engineers met on Friday, the 16th inst., at Storey's-gate, to receive the annual report of the Council for the year 1922, and to discuss a paper on "Some Mechanical Problems in the Rubber Industry," by Mr. H. C. Young.

Dr. Hele Shaw took the chair, and moved the adoption of the report, which was readily agreed to by the meeting. Mr. Thompson, however, made a few remarks on the report, chiefly concerning financial affairs, and Sir John Dewrance explained to him that the increase in the running expenses of the Institution were to be accounted for by the extension of the provincial branches and the increase in the membership and the greater number of meetings,

Dr. Hele Shaw pointed out that the reason why a charge had been made for the tickets for the last two functions—the dance and the reception—was the decision that they should not be supported by the Institution's general funds, as such a policy would give an advantage to the members living in London as compared with those in the provinces or abroad. There were, he said, some 300 people at the dance at the Hotel Cecil, while about 350 were at the reception at the Central College the evening before.

The annual report shows that 1238 new members were elected during 1922, and that the net addition amounted to 740, so that there were, at the end of the year, 8734 members. The accounts show that the total revenue was some £28,655, while the expenditure was just over £28,737.

The Alloys Research Committee reports that its research on light alloys has been brought to a satisfactory position for the present by the publication of its eleventh report. It has been decided that a comprehensive research on the alloys of iron should be undertaken in co-operation with the Department of Industrial Research, the Iron and Steel Institute, and the Worshipful Company of Armourers and Brasiers. The several contributions to the expenses amount to £4275. The research is to be carried out at the National Physical Laboratory. The work of the Cutting Tools Research Committee included the experiments of Professor Coker on the action of planing tools and milling cutters with the aid of polarised light and transparent models; some tests by Colonel Crompton on the effects of thickness of chip and speed on the power consumed by lathes; and the determination by Mr. Dempster Smith of the forces at the cutting edge of a tool when taking light cuts; while Dr. Stanton and Dr. Rosenhain have started work on the fundamentals of cutting action. Research work for the Hardness Tests Research Committee has been continued at the National Physical Laboratory under the direction of Dr. Stanton, and the Committee's second report will be presented for discussion at a general meeting in due course. The first report of the Steam Nozzles Research Committee, which contains the results of experiments to determine the efflux angles of steam from nozzles of various types, has been published, while the second report, giving experimental results of the effect of impact of the steam from these nozzles will be presented for discussion at an early meeting of the Institution. Work for the Wire Ropes Research Committee has been carried out by Dr. Scoble at the Woolwich Polytechnic on repeated bending tests of wire ropes over pulleys, and a report of the first series of experiments is in course of preparation.

Following the classic work on marine engine trials carried out by the Institution from 1887–1894, a Committee, consisting of representatives of the Institution of Mechanical Engineers and the Institution of Naval Architects, has been appointed with the objects of carrying out tests on oil engines and of reporting on the performance of motor-driven vessels. The Engineer-in-Chief of the Fleet has, with the approval of the Admiralty, joined this Committee. The proposed trials will include economy trials and fuel consumption tests ashore and manœuvring tests at sea. Wherever possible, the behaviour of the propellers and the hull will be examined. The preparation of the forms for the conduct of the proposed trials has been carried out by the Joint Committee under the chairmanship of Sir George G. Goodwin. It is intended to test engines of as many representative types as possible. In addition to the offer of Richardsons, Westgarth and Co. of a ship for trial purposes, negotiations have been in progress with other engine builders for the offer of similar facilities. Up to the present seven firms have agreed to participate. The engines built by these firms represent five distinct types. An appeal for financial help will be issued shortly to the firms interested.

Reference is made in the report to the changes in the articles of association and by-laws, which resulted in the creation of new classes of graduates, students, companions and associates, and the equalisation of the rates of subscription for home and foreign members. A new branch of the Institution has been established for Glasgow and the West of Scotland. During the year fourteen papers were read and discussed at the meetings.

The President then presented the usual prizes. The Thomas Hawksley Medal went to Professor Rateau, of Paris, who unfortunately was ill and could not attend the meeting. It was to be sent to him with a message hoping for a speedy recovery. Graduates' prizes of £5 were presented to Messrs. E. T. Vincent and F. Arnold Best, while prizes of £5 each for the Institution examination papers were awarded to Messrs. R. P. Irwin, S. W. Smith, and Hanson.

The Secretary then announced the election of the officers for the ensuing year, as follows:—President, Sir John Dewrance; Vice-presidents, Sir Robert Hadfield and Mr. H. A. Ivatt; members of Council, Mr. Daniel Adamson, Mr. W. F. Cully, Professor Dalby, Mr. C. Day, Mr. E. W. Moss, and Lieut.-Colonel Pitt. It was further announced that at the Council meeting that afternoon Sir Robert Hadfield had been appointed a Past Vice-president, and that Mr. William Reavell had been made a Vice-president to fill the vacancy thus created. In addition, to fill other vacancies, Mr. Richard Williamson, Sir George Goodwin and Mr. R. E. L. Maunsell had been appointed members of Council.

In vacating the chair in favour of the new President, Dr. Hele Shaw remarked on the large increase in the number of ballot papers which had been returned this year, and attributed the fact to the added interest taken by the associate members since some of the candidates for the Council had been nominated from their ranks.

When Sir John Dewrance had taken the chair, Captain Riall Sankey called for a vote of thanks for Dr. Hele Shaw, who had had an unusually busy time as President. Mr. Thompson seconded the proposal, which was also supported by Mr. Whitaker, and carried with great acclamation. In replying, Dr. Hele-Shaw said that he had always wanted the Institution to be recognised as representing mechanical engineering throughout the world, and it was gratifying to know that the Government now accepted membership for the Institution as a qualification for employment in the public services.

Rubber Machinery.

Mr. Young then presented his paper, part of which we reprint on page 196 of this issue. He said that rubber was truly an engineering material, and that it was capable of much wider use than it at present enjoyed. In its manufacture numbers of mechanical engineering problems were involved, and the rubber factory was a paradise for engineers. Unfortunately, however, it had been the practice in the past to ask engineers to design, and to manufacture, plant for use in rubber factories without giving them facilities for learning the conditions under which the machines would operate. That policy had been discarded in America now, and in England it was also fading away. Mr. Young showed a number of lantern slides, some of which contrasted the British and American types of factory, the former generally being of single-storey construction, while the American buildings were five storeys high and measured some 500ft. by 100ft. They were mostly built of concrete. Some of the other slides illustrated new types of machines for mixing and washing rubber, with which it had been found possible, after carefully studying the working conditions, to cut down the power consumption very considerably. The author exhibited a number of diagrams indicating the variations in the power required for various operations, and another which, by comparing the performances of several machines, indicated the probability that their designs were anything but standardised. Some photographs of broken rolls showed, said Mr. Young, that designers would have to re-consider the stresses to which they were working. He also said that there was a demand for a satisfactory automatic weighing machine for dealing with the powders mixed in with the rubber.

The discussion was opened by Mr. Daniel Adamson, who thought that it would have added to the interest of the paper if it had included an explanation of the processes of manufacturing rubber. He remarked that the crude rubber was first washed by passing it between fluted rolls or between rolls running at different peripheral speeds. It was then passed through heated rolls to convert the granulated substance into a coalescent mass. The next step was to mix it with the necessary powdered materials, warm it up again, and finally to calender it out into sheets or extrude it into threads. Mr. Adamson said that in America it was generally considered necessary to provide 1½ horse-power for every inch in the width of the rolls and therefore wondered if the author had not underestimated the requirements in putting them at 1 horse-power per inch. The power did, of course, fluctuate very violently, as it only took about one second for a lump of rubber to pass between the rolls, and during the process there was a peak overload of about 100 per cent. It was, however, possible by arranging a set of six mills together to reduce the total maximum power demand to about four and a-half times that required for each mill separately. With regard to the safety devices on mills, he said that it was most important that they should operate properly, as attending a mill was a very dangerous occupation, and he suggested that the safety device should always be used as part of the ordinary operating mechanism of the machine. It had been found that if the current were cut off from the motor driving the rolls they would continue to travel for 75in.; if, at the same time, the motor was de-clutched, the travel was reduced to 16in.; while it was only 4in. if an automatic brake was simultaneously put on the roll. The added safety of the last arrangement was obvious.

Mr. H. Savage (W. T. Henley's Telegraph Works Company) commented on the trouble which might be caused by using the waste steam from vulcanisers for heating purposes, on account of the sulphur it contained, and asked the author how the sulphur was removed. It might be possible, as Mr. Young suggested, to use alternating-current motors for driving some of the machines; but he believed that it had been found necessary, at least in America, to use direct-current motors for driving calenders and extruding machines on account of the necessity for adjusting their speed within fine limits. Mr. Savage said that although the author had suggested that mechanical engineers were more or less excluded from rubber factories, in his opinion there really were many of them employed in the industry.

Mr. J. H. C. Brooking (St. Helens Cable and Rubber Company), said that several papers concerning the rubber industry had been read in the past, but they had all been presented to chemical societies, and although the mechanical side of the business was undoubtedly very important, the chemical side was even more so. He had found that there were all kinds of mechanical problems to be dealt with in a rubber factory, and that no information bearing on the subject had been published. One of the great difficulties which had to be contended with was the testing of the materials, as they could not be tried in the convenient manner that the mechanical engineer employed in testing metals for instance. Rubber tires could only be tested by actually running them on the roads.

Mr. H. Rogers (James Lyne Hancock, Limited) also joined in the discussion.

In replying, Mr. Young pointed out that it was practically impossible to fix definitely the amount of power required by rubber machinery, as there were so many variable factors to take into consideration. Thus the temperature, the thickness of the rubber, the nature of the mixture, and even the metal of which the rolls were made, all influenced the demand of the machines for power. Sulphur in steam certainly did attack valves and pipe fittings through which it passed, but the steam coming from vulcanising presses used in the making of tires did not contain sufficient sulphur to do serious harm. On the other hand, that coming from tube presses could not be used as it was too sulphurous. It was, he said, quite possible to use alternating current for driving all the machines in a rubber factory, as commutating motors could be used where speed regulation was necessary, as in the case of calenders. He knew of two such motors—one of 60 horse-power and the other of 120 horse-power, working an extruder—that were running most satisfactorily.

Obituary.

ADAM SCOTT.

The death is announced of Adam Scott, M. Inst. C.E., which occurred in London on February 13th, 1923, at the age of sixty-eight.

Mr. Scott was an engineer of high repute who early in life distinguished himself by his painstaking attention to detail in connection with the various engineering enterprises of consequence with which he was associated, dating back to something like 1880. There is evidence of Mr. Scott's talents, sagacious foresight and wide experience to be found on the Weaver Navigation, the Clyde, the Tyne, the Thames, and at such widely diverse places abroad as Brazil, Gibraltar, Chile and China, principally in relation to river, harbour and dock engineering tasks of huge magnitude. Probably his most noteworthy engagement was that under the Admiralty of Superintending Civil Engineer of the new harbour works and dockyard at Gibraltar, an undertaking started in 1893 and completed about 1906. These works were amongst the largest and most varied of the kind ever carried out anywhere, and involved the expenditure of several millions of pounds, and embraced three large breakwaters, dredging and blasting for the deepening of the enclosed harbour, three large dry docks with their caissons, &c., reclamations from the sea, wharf and retaining walls, large workshops, and store-houses on pile foundations, coaling sheds, offices and other buildings; drainage and sewer works; water supply, large water storage tanks, railways and viaduct; large underground magazines and shell stores; coaling depôt; piercing a tunnel into the heart of the rock, and much other work of a confidential nature. Mr. Scott read a paper dealing with the Gibraltar improvements before the Institution of Civil Engineers in 1914.

Prior to the foregoing, Mr. Scott had prepared the whole of the working drawings and carried out the whole of the work without a contractor in connection with the rebuilding of a portion of Newcastle Corporation's deep-water quay. The substructure consisted of a system of large well monoliths of concrete, 30ft. by 20ft., with a well 20ft. by 10ft., which was sunk through a bed of quicksand and mud. A paper which he prepared on this work was awarded the Telford Premium by the Institution of Civil Engineers.

In 1907 Mr. Scott was appointed Technical Adviser and Engineering Chief to the Chilean Government for Port Works, and surveyed, sounded and reported upon some of the principal seaports of Chile, with preliminary plans and estimates. About 1911 he completed detailed estimates for proposed improvements at the Chilean ports of Valparaiso, Antofagasta, Mejillones, Iquique, and Arica, the total cost of these undertakings reaching close upon £6,000,000. In 1919 he specially visited Brazil again to make investigations and report upon the proposed improvements to the port of Prabyba, and during the past year or so had been engaged in completing working drawings, with a report and specification for a comprehensive project in connection with some large harbour extensions in China.

Mr. Scott was responsible for a number of technical papers, and contributed extensively to engineering literature.

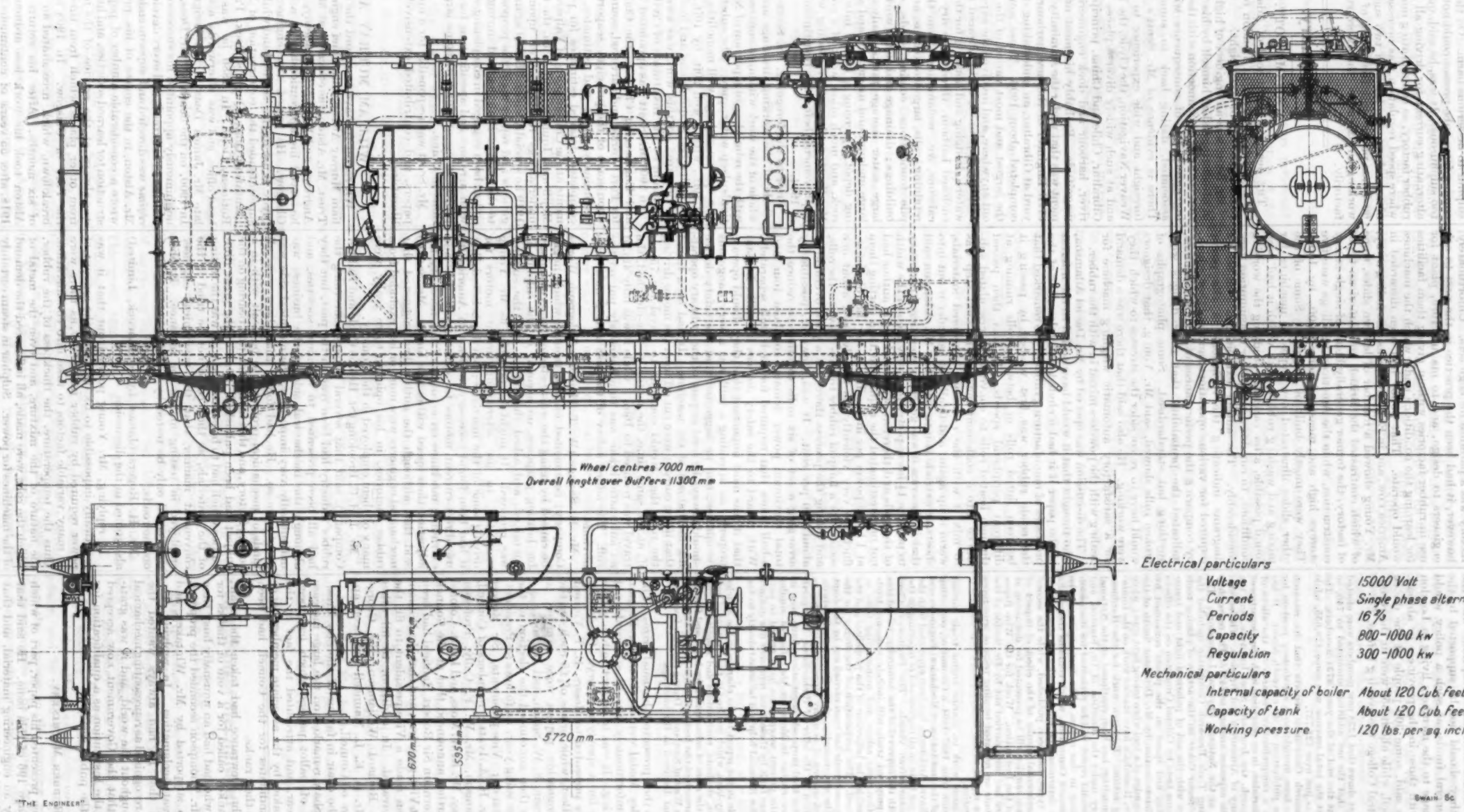
WILLIAM MURRAY ALSTON.

We regret to have to record the death of Mr. William Murray Alston, late chief engineer of the Clyde Trust. Mr. Alston was educated at Madras College, St. Andrews, and Larchfield Academy, Helensburgh, but he served his apprenticeship as a civil engineer in Glasgow. He joined the engineering staff of the Clyde Trust in the 'sixties, and while so employed he superintended the construction of Mavisbank Quay, Plantation Quay, Queen's Dock, Princes Dock, and Rothesay Dock. In 1880 he was attached to the head office, and was afterwards associated with the late Mr. James Deas in the designs for new works. In 1900, on the death of Mr. Deas, Mr. Alston was unanimously appointed his successor. The harbour continued to extend, and every development during his *régime* was directed and superintended by Mr. Alston. Mr. Alston, in the course of his professional career, wrote a considerable number of papers on dock construction for learned societies, and his wide experience was always at the service of the many deputations from other places which from time to time visited the Port of Glasgow. In 1908 he had a serious breakdown, which necessitated an enforced holiday of six months. After his return to business Mr. Alston took his work less arduously, and in July, 1918, after 55 years of continuous service with the Clyde Trust, he retired.

SWISS FEDERAL RAILWAYS—15,000-VOLT ELECTRIC HEATING WAGON

BROWN, BOVERI AND CO., BADEN, AND SULZER BROTHERS, WINTERTHUR, ENGINEERS

(*For description see page 209*)



Electrical particulars		
	Voltage	*15000 Volt*
	Current	*Single phase alternating*
	Periods	*16⅔*
	Capacity	*800-1000 kw*
	Regulation	*300-1000 kw*
Mechanical particulars		
	Internal capacity of boiler	*About 120 Cub. Feet*
	Capacity of tank	*About 120 Cub. Feet*
	Working pressure	*120 lbs. per sq. inch*

SWAIN Sc.

A 15,000-Volt Electric Heating Wagon.

THE new high-voltage heating wagon, which, after undergoing successful trials, was recently placed in commission on the Swiss Federal Railways, presents interesting features, both in its conception and the way in which the design has been carried out, and in solving the problem which was set before them the joint builders, Brown, Boveri and Co., Baden, and Sulzer Bros., Winterthur, have certainly achieved an advance in electric boiler construction.

It is well known that on electric railways the heating of the coaches is usually effected by means of resistance heaters, but an additional complication is met with in the case of the Swiss lines, on which on through trains a certain amount of international rolling stock must be handled, which stock is invariably arranged for some form of steam heating. At first experiments were made with oil or coal-fired boilers, and later electric boilers equipped with low-tension and high-tension heating electrodes were investigated. It was found that for a large heating output such as becomes necessary with heavy trains, the use of a high-voltage boiler, in which the current is taken direct from the overhead lines, provided the most favourable solution. During the summer of 1920 tests carried out at Berne jointly by the Swiss Federal Railway Engineers' Department, Brown, Boveri and Co., and Sulzer Bros. were made in order to ascertain the reliability of working, the possible degree of regulation, and the best method of dealing with the explosive gases generated at the electrodes. The results obtained were such that the railway authorities commissioned the above-mentioned firms to build a heating wagon for single-phase, 16⅔ period, 15,000-volt alternating current, which should work at about 120 lb. steam pressure and have a capacity of about 800 kilowatts. The general arrangement of the installation, which is built on an ordinary two-axled covered goods wagon, will be seen from the illustrations Figs. 1 and 2 and drawing we reproduce on page 208, while a plan of the general wiring scheme is also given in Fig. 3.

The apparatus consists essentially of a boiler with a built-in pump, which is supported over the containing tank for the feed water, the boiler being fed by two injectors. The current enters from the overhead line through the pantograph collector and passes to the electrodes through the usual arrangement of choking coils, insulators, and oil switches, a special cut-out being provided for each electrode. A 15,000/220-volt transformer supplies current to the motor which drives the circulating water pump. This pump delivers water which impinges at a high velocity on to the electrodes, serving the double purpose of keeping them cool and of preventing the formation of steam bubbles, which at such high electrical pressures, if not instantly removed, readily lead to flashing over. The electrodes are of patented design and are protected by tubes of insulating material. The position of these tubes relatively to the electrodes may be varied, and each electrode is capable of separate control, which gives flexibility as regards steam production. In the above table we reproduce some of the trial figures which were given by Mr. F. Christen, of the Swiss Federal Railways, in an article contributed by him to our Swiss contemporary journal, the *Schweizerische Bauzeitung*.

The wagon is equipped with the usual Westinghouse air brake service, and advantage is taken of the compressed air to operate an automatic locking device on the high-tension transmission chamber. A device is also fitted which lowers the current collector pneumatically when the electrode covers are opened. Emergency switches operated by a time relay are provided, and a hand air pump is fitted, which may be used in case the air service on the train fails.

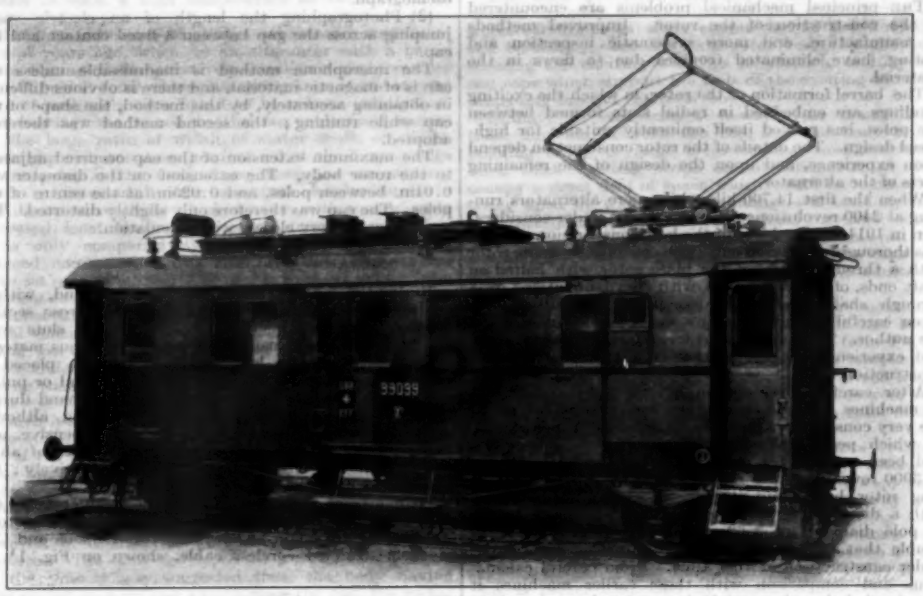


FIG. 1—ELECTRIC HEATING WAGON FOR RAILWAY WORK

Train Test.—16 *Coaches*, 45 *Axles*, *Heating Car in the Middle*, *March 9th*, 1921.

Bern to Thun.									Thun to Bern.								
Time.	Boiler readings.		Pressure.		Motor.	Heating pressure.	Position of electrodes	Remarks.	Time.	Boiler readings.		Pressure.		Motor.	Heating pressure.	Position of electrodes.	Remarks.
			Boiler.	Pump.								Boiler.	Pump.				
	Amps.	Volts.	Lb. per sq. in.	Lb. per sq. in.	Amps.	Lb. per sq. in.				Amps.	Volts.	Lb. per sq. in.	Lb. per sq. in.	Amps.	Lb. per sq. in.		
6.55	0	0	44	50	0	0	36	Outside temp. 5 deg. C., average wagon temp. 6 deg. C.	8.50	20	14,300	85	100	16	0	35	One electrode No. 2 in circuit
7.02	20	14,000	44	58	18	0	35	One electrode in circuit	8.53	37	14,000	95	110	15	64	5	
7.05	42	14,000	55	67	17	0	7	Two electrodes in circuit	8.55	20	12,800	79	82	8	61	3	Pump shut off
7.10	66	12,500	102	113	15	82	5		9.05	40	13,500	89	102	15	0	2	Heating on
7.19	52	14,200	92	98	13	82	0	Stop at Ostermundigen	9.12	23	12,500	100	102	10	83	2	Pump shut off, heating on
7.29	40	13,500	104	117	15	95	35										
7.31	59	13,500	102	114	16	94	5	Left Ostermundigen	9.17	26	13,800	91	100	15	67	2	
7.42	65	13,300	98	107	15	85	5		9.25	26	13,800	82	92	15	67	2	Test run completed
8.00	*60	13,500	100	111	15	92	6										
8.10	56	14,000	116	127	15	108	10		Water used from Bern to Thun .. .. About 2970 lb.								
8.14	61	13,000	101	116	14.5	97	10	Thun, test run completed	Power used .. .. 995 kilowatt-hours								
									Temperature increase .. .. 22 deg. to 30 deg. Cent.								
									Water used from Thun to Bern .. .. About 780 lb.								
									Power used .. .. 250 kilowatt-hours								
									Temperature increase .. .. About 5 deg. Cent.								

FIG. 2—INTERIOR OF HEATING WAGON

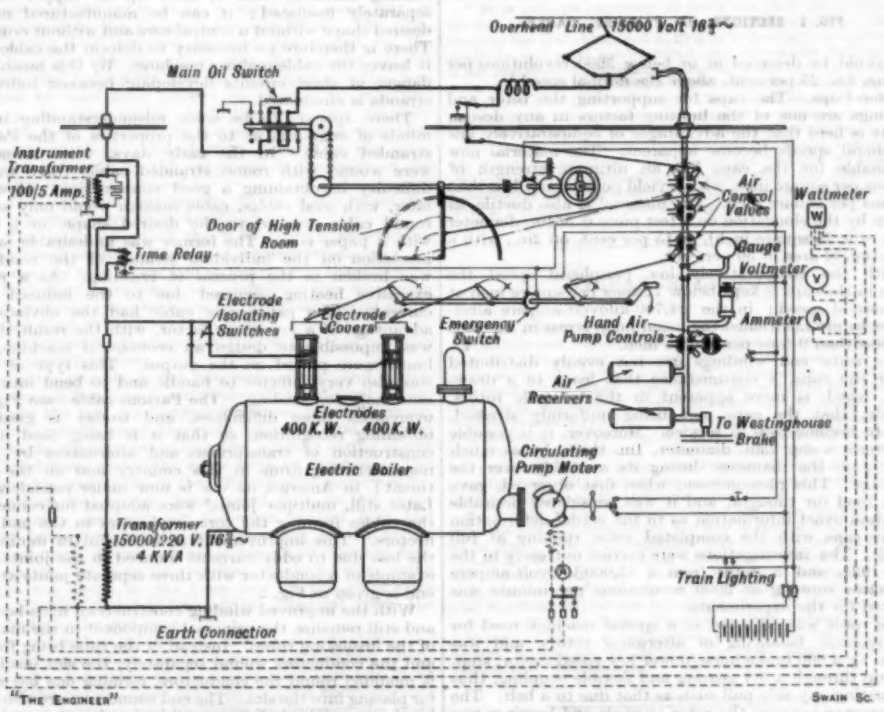


FIG. 3—DIAGRAMMATIC SKETCH OF ARRANGEMENT OF HEATING WAGON

Some Problems in High-speed Alternators, and their Solution.*

THE principal mechanical problems are encountered in the construction of the rotor. Improved methods of manufacture, and more systematic inspection and testing, have eliminated troubles due to flaws in the material.

The barrel formation of the rotor, in which the exciting windings are embedded in radial slots formed between the poles, has proved itself eminently suitable for high-speed design. The details of the rotor construction depend upon experience, and upon the design of the remaining parts of the alternator.

When the first 14,700-kilovolt-ampère alternators running at 2400 revolutions per minute were under consideration in 1914, the problem of the best construction of rotor was thoroughly thrashed out. The merits of the plate rotor with a through shaft, of the plate rotor with bolted-on shaft ends, of the rotor built with thin laminations on a through shaft, and of the single-forging rotor, were given careful consideration by Sir Charles Parsons and the author. The simple solid forging was finally chosen, and experience has shown that it is the most suitable construction.

After careful consideration of the peripheral speeds of machines already running, it was decided to adopt the very conservative and safe figure of 300ft. per second, at which peripheral speed several Parsons alternators had been running for many years at speeds from 1000 to 3000 revolutions per minute. Obviously this meant a long rotor body, and its length was actually 105in., with a diameter of 29in., giving a ratio of pole length to pole diameter of 3.62; this ratio was more than double that of any large alternator, either running or under construction, at that time. From careful calculations and comparison with these earlier machines it was decided that there might be a critical speed at 1600 revolutions per minute. (On running the rotor of the first of these machines later, it was found to be slightly rough between 1200 revolutions per minute and 1600 revolutions per minute, but after the final balancing no undue vibration could be detected at or below 3000 revolutions per minute, *i.e.*, 25 per cent. above the normal speed.)

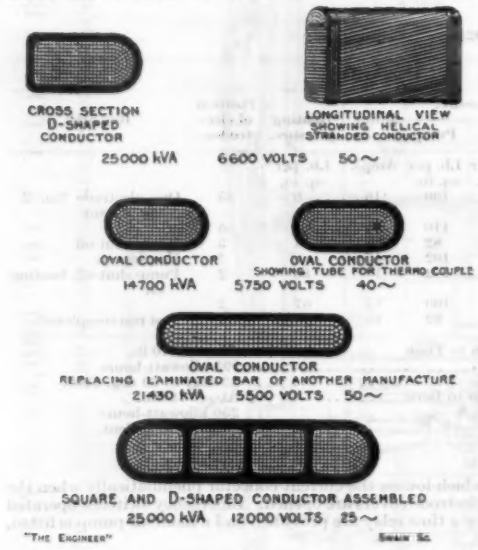

CROSS SECTION D-SHAPED CONDUCTOR
LONGITUDINAL VIEW SHOWING HELICAL STRANDED CONDUCTOR
25000 kVA 6600 VOLTS 50~
OVAL CONDUCTOR
14700 kVA
OVAL CONDUCTOR SHOWING TUBE FOR THERMO COUPLE
5750 VOLTS 40~
OVAL CONDUCTOR REPLACING LAMINATED BAR OF ANOTHER MANUFACTURE
21430 kVA 5500 VOLTS 50~
SQUARE AND D-SHAPED CONDUCTOR ASSEMBLED
25000 kVA 12000 VOLTS 25~
"THE ENGINEER"
SWAIN SC.

FIG. 1—SECTIONS OF PARSONS' CABLE

Rotor Caps.—The caps for supporting the rotor and windings are one of the limiting factors in any design, and it is here that the advantages of comparatively low peripheral speeds become apparent. The material now obtainable for the caps has an ultimate strength of 65 tons per square inch, with a yield point of not less than 48 tons per square inch. The material is also ductile, as shown by the elongation on a test piece 0.564in. diameter (area = 0.25 square inch), of 15 per cent. on 2in., with a reduction of area of 50 per cent.

With the comparatively low peripheral speed the stress in the caps is kept below 12 tons per square inch at the normal speed; in the 14,700-kilovolt-ampère alternators before mentioned the mean hoop stress in the caps was less than 9 tons per square inch.

The rotor end windings are not evenly distributed under the caps, a circumstance that leads to a drawback, which is more apparent in the two-pole rotors, namely, that the caps, not being uniformly stressed, tend to become oval in service. Moreover, it is possible to deform a cap 25in. diameter, 1in. thick, by as much as ¼in. on the diameter during its assembly over the windings. This phenomenon, when first observed, gave much food for thought, and it was considered desirable to obtain exact information as to the actual deformation of the caps with the completed rotor running at full speed. The investigations were carried out early in the year 1921, and a rotor from a 15,000-kilovolt-ampère alternator running at 3000 revolutions per minute was selected for the experiments.

The rotor was adjusted in a special machine used for the dynamic balancing of alternator rotors, and was driven by a 600 brake horse-power low-speed motor, stepping up through a 6/1 gearing and flexible coupling, thus eliminating any side pull such as that due to a belt. The oil clearance between the rotor journals and bearings was a minimum.

The excentricity of the cap was obtained by measuring the varying clearances between the cap and a fixed point or contact.

Two methods of obtaining the excentricity were originally proposed:—

(1) Using a microphone to record the loudness of the note in a telephone receiver, or to give a record on an oscillograph.

(2) Photographing the length of an electric spark jumping across the gap between a fixed contact and the cap.

The microphone method is inadmissible unless the cap is of magnetic material, and there is obvious difficulty in obtaining accurately, by this method, the shape of the cap while running; the second method was therefore adopted.

The maximum extension of the cap occurred adjacent to the rotor body. The extension on the diameter was 0.01in. between poles, and 0.025in. at the centre of the poles. The cap was therefore only slightly distorted. The results agreed very closely with calculation.

STATOR WINDINGS AND INSULATION.

Early alternator stators were hand wound, with a continuous length of cable, of the same cross section throughout. The insulating tubes in the slots were moulded separately, usually of tape and fibrous material such as presspahn or leatheroid. They were placed in position in the slots, and the cable was wound or pulled through them. The cable was insulated by hand during the process of winding. This construction, although of proved reliability, was laborious and expensive, and became more difficult with the increasing size of alternators. The winding space was not used effectively; the output was limited and the coat unduly high.

To overcome these difficulties, the conductors in the core are now made separate from the end connectors. The former are made by Messrs. C. A. Parsons and Co., of their stranded coreless cable, shown on Fig. 1[1], in which the individual strands are insulated and spiralled in a definite lay, to eliminate eddy-current losses in the cable. The end connectors are made of copper straps, which form a good mechanical construction for bracing against the forces set up in the winding at the moment of sudden short circuits.

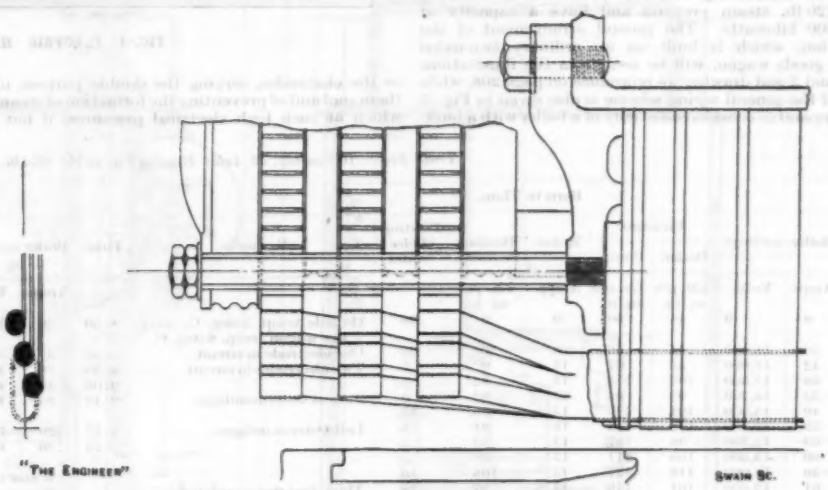


FIG. 2—MULTIPLE JOINTS FOR STATOR END CONNECTIONS

The cable employed is constructed on a special cable-making machine,[2] and is built up of copper strands separately insulated; it can be manufactured in any desired shape without a central core and without crushing. There is therefore no necessity to deform the cable after it leaves the cable-making machine. By this means, the danger of short circuits developing between individual strands is eliminated.

There appears to be some misunderstanding in the minds of engineers as to the properties of the Parsons stranded cable. In the early days, when armatures were wound with round stranded cable, there was no difficulty in obtaining a good construction. However, later, with oval cables, cable makers would only supply round cable crushed to the desired shape, or a cable with a paper core. The former was undesirable, as the insulation on the individual strands of the conductor was broken in the process of crushing. As a result, excessive heating occurred due to the induced eddy currents. The paper core cable had the obvious disadvantage of a low space factor, with the result that it was impossible to design an economical machine, and limits were placed on the output. This type of cable was also very difficult to handle and to bend into suitable shape for winding. The Parsons cable—see Fig. — overcomes these difficulties, and to-day is gradually obtaining recognition, so that it is being used in the construction of transformers and alternators by other manufacturing firms in this country and on the Continent; in America its use is now under consideration. Later still, multiple joints[3] were adopted for connecting the cables forming the core conductors to the end connectors. This improvement is successful in minimising the loss due to eddy currents induced in the joints. An example of a conductor with three separate joints at each end is given in Fig. 2.

With the improved winding construction, mica became, and still remains, the principal component in the material of the insulating tubes. Instead of the tube being formed and the conductors wound separately, the slot insulation is moulded round the conductors, forming one bar ready for placing into the slot. The end connectors are also insulated separately before assembly in the stator; after assembly, it is only necessary to insulate the joints connecting the end windings with the slot conductors. With these new methods employed in winding, it has become possible to use improved insulating materials, and to supervise more strictly this important part of the work.

In earlier practice, methods of manufacture had been developed in which the insulation moulded round the conductors formed a compact mass with the copper, and had almost a metallic ring when knocked with a hammer; conductors insulated in this way made a great appeal to engineers, owing to their resemblance to a metallic structure. The disadvantages of this method of insulation did not appear until later.

During 1913, on drying out the stator windings of a 2500-kilovolt-ampère 6600-volt alternator, cracks developed in the hard insulating tubes, which broke down to earth under the high-pressure insulation test. The reason for this failure was not appreciated until a similar fault developed on another stator, and the whole position was investigated. The explanation is a simple one. When the alternator gets hot, the conductors and insulating tubes expand and lengthen. The copper conductor, having the higher coefficient of expansion, lengthens more than the tube and, as both form a solid mass, one has to give way. It is always the tube. This illustration shows clearly how a modification, although apparently an improvement, may have disadvantages which only develop on trial under operating conditions. It shows also the necessity for caution in departing from proved methods of construction.

To remove the expansion difficulty, and to retain the insulating tube moulded directly on to the conductors, it is necessary to use an insulation having the same coefficient of expansion as that of copper, or, alternatively, to make the insulation sufficiently flexible to take up the difference in expansion. The former solution is not yet obtainable. A flexible mica insulation had therefore to be devised. This insulation, after a great deal of investigation, was finally obtained and, when the spirit has been evaporated from the varnish binding the mica flakes together, the remaining oils ensure that the insulation retains sufficiently elastic properties at the operating temperatures of the alternator. It must be remembered that the sides of the conductor slots also grip the insulating tube; just as between the copper conductor and the tube there is relative movement, so also is there between the tube and the iron core. Flexible insulation has provided a satisfactory solution of both difficulties.

As an alternative, if a hard moulded insulation is used, the following precautions should be taken. A thin layer of flexible insulation should be applied between the conductor and the hard tube, and also outside the latter. This outer layer of elastic material might be applied to the sides of the slots so as to present a smooth surface to the insulating tube. A suitable bituminous compound, becoming elastic at the operating temperatures, would serve the purpose.

It must be borne in mind that whatever insulation is employed must not be brittle. If brittle insulation is used, cracks will also develop when the windings are subject to the forces occurring on short circuits. The insulation must not pulverise. Too much stress cannot be laid upon these qualities.

Experience has proved that movement of the end windings as a whole cannot entirely be prevented. On one occasion a dead short circuit occurred across the terminals of one of the largest alternators while on full load. Careful examination showed that, owing to the shrinkage of insulation and packings relieving the pressure of the clamps, the stator end windings in one place had moved ¼in., but had afterwards sprung back to their normal position.

STATOR SLOTS.

In the author's opinion, the tunnel formation of slot for receiving the stator conductor bars has many advantages over the open slot formation. The construction may be a little more expensive to manufacture, but, when correctly designed, the windings are more accessible for examination and withdrawal, if necessary, than former-wound coils in completely open slots. This advantage is more noticeable in turbo-alternators, as the number of poles rarely exceeds two or four, giving a long winding pitch. The advantages are also still more apparent in the largest turbo-alternators, since the number of conductors per slot is small.

The slot is punched with a full radius top and bottom, giving a sound mechanical construction of core, and the insulating tube, of the oval cross section required to fill the slot, is readily moulded around the conductor bar.

With the tunnel slot construction, the flux pulsations are minimised, and, as the stator bore has an uninterrupted contour, the circulating currents induced in the rotor body are reduced to a minimum and the efficiency

* Abstract of paper read before the Institution of Electrical Engineers by Mr. J. Rosen.

[1] British Patent, Nos. 16,620/08 and 184,574.
[2] British Patent, No. 16,620/08.
[3] British Patent, No. 126,124.

of the alternator is improved. In the closed slot construction the leakage of flux across the iron bridge enables a high inherent reactance to be obtained without resorting to abnormal proportions of the slot.

Again, by the use of the tunnel slot it is possible to obtain an alternator voltage wave form entirely free from ripples. With the open type of slot it is difficult to remove the ripple at the peak of the voltage wave form. Oscillograph curves given in the paper show that there are no pronounced harmonics, and on load the maximum deviation from a sine wave of the pressure between the line terminal and earth is 2.1 per cent.

VENTILATION.

With the larger sizes and longer lengths of alternators (necessitated by comparatively low peripheral speeds) it becomes more difficult to ensure uniform cooling. In the usually accepted schemes of ventilation, air is drawn or forced in from the ends of the alternator only. The available area for the passage of air is limited, and the air is heated before getting to the centre of the alternator, which is consequently the hottest part. Such local high temperatures limit the output.

To obtain a scheme of ventilation in which the alternator shall be cooled uniformly throughout its entire length should be the aim of all designers, and it is necessary that the construction should be simple and easy to manufacture. Such a method is described in British Patent No. 15,585/1914, and, so far as the author is aware, the practical application of this scheme of ventilation is unique. The alternator, for ventilation purposes, is divided into separate air circuits in parallel, each with low resistance to the passage of the air. By this subdivision the alternator can be designed to have any desired length, and still be uniformly cooled. Fans attached to the rotor or separately driven fans can be used.

Air Cleaning.—A large quantity of air is used to cool an alternator, and its weight may actually exceed that of the steam passing through the turbine per unit time; it is therefore essential that the air should be clean.

After experiments had been made with wet filters, tests were started on a design of air cooler which was, in fact, a motor car radiator in reverse operation, its function being to absorb heat from the air instead of to dissipate it. The cooler under test had copper tubes with sheet iron gills, and was in reality a radiator taken from a 4-ton lorry. As a result of only a few experiments, it was found that such an air cooler was a commercial proposition. Elaborate experiments were carried out with an enclosed system of ducts, with the same air repeatedly circulated. An electric heater was used in the ducts for heating the air, the heat being subsequently extracted by the cooler.

Credit should be given to the staff of the Battersea Corporation electricity works, who, in 1912, took out a patent for a cooler using water from the condensate, and proved the advantages of the enclosed air system. They installed their first cooler at Battersea power station, using plain tubes. The whole question was discussed with Messrs. Merz and McLellan, and an alternator air cooler, to deal with 18,000 cubic feet of air per minute, was installed in 1919 by Messrs. Parsons, on a 3000-kilowatt plant, in the Blaydon power station of the Newcastle-upon-Tyne Electric Supply Company, to which credit should also be given for placing an order for experimental plant for commercial use. This alternator air cooler, which, since its installation, has run without any fault developing, was the first design with gilled tubes to be installed and put into commercial operation in this country. The Parsons Company has a number of coolers for alternators, with a total capacity of a quarter of a million kilovolt-ampères, either in operation or under construction, for this country or abroad. At the time the above-mentioned cooler was installed, the General Electric Company of America was apparently experimenting on the same lines, and some of its results were published.[4]

Water Cooling.—The use of a liquid cooling agent has always appealed to the designer of dynamo-electric plant. It was first applied to electrical machinery by Sir Charles Parsons in his original very high-speed dynamos, built during the period 1884 to 1889. The armature shafts of these dynamos were hollow, and cool oil was continuously pumped through to the outboard bearing. The innovation was subsequently discarded as relatively ineffective.

In 1904 or 1905, an alternator was built in which, as an experiment, water pipes were fitted in the radial ducts of the stator core, the dimensions of the ducts being similar to those of the customary air passages. Later, in 1905, the stator core of another alternator was cooled by a group of longitudinal water pipes, which passed through specially provided tunnels and were connected to water boxes forming the supports for the ends of the core. In the most modern schemes[5] of water cooling used at present the rotor is cooled by water which enters and leaves at the same time, giving uniform cooling throughout and avoiding the complication of having water connections at the coupling end of the rotor.

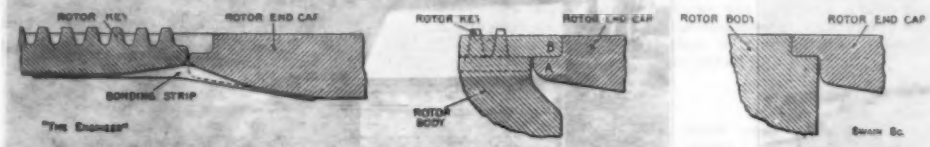
EDDY CURRENTS IN ROTORS.

It has long been recognised that in three-phase turbo-alternators voltages are induced in the rotor, resulting in currents circulating in the rotor windings and body—more especially near the periphery of the latter. These voltages are induced in normal operation by flux pulsations, set up by variations in the stator current, or by periodic changes in the reluctance of the magnetic circuit. The resulting eddy currents increase the temperature of the alternator, lower its efficiency, and also, as is now known, may reach a magnitude sufficient to heat the metals to such a high temperature as to affect their mechanical properties.

The first indication of serious overheating was found several years ago, when, in an alternator with a barrel rotor having a comparatively small air gap between the stator and rotor, the coil-securing keys at the lagging edge of each pole were found to have been unduly hot. The heating was traced to the flux pulsations caused by the large ratio of width of stator tooth to length of air gap; it was more pronounced at the lagging edge of the pole, as the flux of an alternator on ordinary loads is distorted by the armature ampère turns in this direction, reaching a high density, with consequently increased local heating. Another difficulty is arcing. It is only comparatively recently that the voltages induced in the rotor body have reached such a value as to set up arcing. Signs of arcing were traced between adjacent sections of keys securing the winding coils in the slots, and between the spacer pieces fitted in the radial ventilating ducts on the plate type of rotor. The arcing was eliminated by the use of metal bonding strips fitted under the keys, the centrifugal force of the coils forcing the bonding strips into intimate contact with the keys.

Three years ago, during the annual overhaul of a large turbo-alternator, small cracks were found on the lips of the rotor caps where they were spigoted into the rotor body. This defect was found after two years' continuous operation.

A microscopic examination of the cap material indicated the presence of small amounts of slag, which, however, in themselves, were insufficient to cause the fractures. The fault developed on a water-cooled rotor. At the time it was suggested that, the body having been cooled to a greater extent than the cap, the radial clearances allowed in the standard construction of rotor without water cooling were too small, and thus heavy stresses had been produced in the spigot of the cap. The clearance was therefore increased. After the machine had been used for a further twelve months, the rotor was again removed for inspection, and it was found that the flaws had again appeared, on this occasion distinct signs of arcing on the cap spigot being apparent.



FIGS. 3, 4 AND 5—DIFFERENT ARRANGEMENTS OF END CAPS

The cap material was pitted and bore traces of local heating; it had become locally brittle, and the small cracks had consequently developed. After careful investigation it seemed clear that the eddy currents induced in the rotor during normal operation were insufficient to cause the arcing, but that very heavy currents might have been induced by sudden short circuits on the alternator.

At the time this question came up for discussion, a 7500-kilovolt-ampère 6600-volt 3000 revolutions per minute three-phase alternator was being subjected to special sudden short circuit and field-breaking tests at the Heaton works. It was decided to remove the rotor end caps, and to make a careful examination after the tests had been completed. The result was very convincing.

It was found that arcing had taken place between the caps and the rotor body in much the same way as had occurred in the water-cooled alternator. The principal arcing had occurred between the faucet on the rotor body and the cap spigot, also, to a smaller extent, between the rotor keys and the cap spigot. This was ascribed to—and later proved to be due to—the fact that, in the rotor under test, the keys were partially insulated from the caps by varnish. It was clear that comparatively high voltages were induced in the rotor windings and body by the variations in the value of the alternator main flux caused by:—

(*a*) The variation of currents in the stator when the stator windings were short circuited.

(*b*) The interruption of the field current effected by a quick-break switch without a discharge resistance.

The remedy may be applied to the rotor in two ways:—

(i) By short circuiting, *i.e.*, bonding the caps into contact with the rotor body, or by providing special short-circuiting rings at the end of the body.

(ii) By insulating the cap from the body so that currents will not stray into them.

The latter remedy is the less satisfactory, and, moreover, more difficult to accomplish without radical departure from the best mechanical construction of the rotor. The first remedy was therefore adopted, and effected in a simple way by extending the bonding strips above mentioned from under the rotor keys to the caps. The modification was made on the 7500-kilovolt-ampere alternator which had already been tested, but, as this plant was urgently required for shipment abroad and had already been considerably delayed owing to the earlier extended tests, it was not again placed on the test bed. Fortunately, an exactly similar machine was going through the shops at the time and all the tests were repeated, with the bonding strips extended from the rotor body to the end caps.

After a number of tests on this second machine, the rotor and caps were removed and the bonding strips examined. A number of the strips were found to have fused at the points where the caps join the body, proving that heavy currents had been passing between the body and the cap; the caps and rotor body showed no marking.

Bonding strips of larger cross-sectional area were then fitted, and the stator again subjected to severe short circuit and field-breaking tests. After the removal of the caps, the bonding strips were found to be intact, and neither caps nor rotor body showed any signs of arcing or local heating.

It is interesting to record that the two machines satisfactorily withstood more than 100 dead short circuits during these investigations, some of which were made at 25 per cent. above normal voltage.

The tests proved conclusively that, with suitable design, the eddy currents induced in a rotor during the worst conditions of short circuit and of field-breaking can be readily carried by the rotor body, by the keys securing the exciting windings in position, and by the end caps which support the ends of the exciting windings projecting beyond the rotor body.

Difficulty is experienced, however, in transmitting these currents between the cap and the body unless bonding strips of large cross-sectional area are used. Such thick bonding strips are objectionable, as they occupy a great deal of space which would be more effectively filled by the exciting windings. A bonding strip was therefore designed, having a local increased cross-sectional area to fill the clearance space between the cap and the body, as illustrated in Fig. 3, the caps and keys being shaped, if necessary, to take the additional copper area.

Referring again to the large alternator mentioned the metal of the end cap where cracked did not break away, and the reason for this will be clear from Fig. 4, which illustrates the standard construction adopted by Messrs. Parsons. The small pieces of metal which might have been broken off by the centrifugal stresses were held by the overhanging lip or faucet B of the rotor body. The fractures occurred at A.

The author has knowledge of certain rotors designed with the caps spigoted over the rotor body, where, in addition to other damage, pieces from the cap, each weighing approximately ¼ lb., had broken away and caused damage to the alternators, necessitating their being rebuilt. At the time, various explanations were put forward as to the cause of the failures, but the author suggests that they may have been due to eddy currents. This is rather confirmed by considerations referred to later in the paper.

The rotors in question were spigoted as shown in Fig. 5, a method which is perhaps more frequently adopted, both in England and on the Continent, than that illustrated in Fig. 4, which, however, the author considers to be the best practice.

[4] *General Electric Review*, 1920, vol. 23, p. 99.

[5] British Patent, No. 16,986/1914.

THE INSTITUTE OF PATENTEES.

THE secretary of the Institute of Patentees writes to us as follows:—"We do not think many of your readers are aware of the existence of this Society, the one object of which is the protection of the inventor. It has been organised for a little over a year, and it has no self-seeking motives. The whole scheme is to protect the results of the work of its members and to assist them to meet likely manufacturers. The Institute of Patentees is affiliated to the National Union of Manufacturers, itself a very important and active organisation. It has been a source of great surprise to us that such a Society is not better known. The entrance fee for full membership is £3 3s. and the annual subscription £2 2s. There is no entrance fee for associate membership, only an annual subscription of £1 1s. The supporters of the Institute can send up patents and they can receive reports upon them from men who are absolute experts in different branches.

"We must make it clear that the services of the officials of this Institute are given absolutely for nothing, the whole point being that if a large membership is attained, as will undoubtedly be the case before long, their strength by united effort will be enormous. The Institute now has a membership approaching 1000.

"Considerable progress has been made towards alleviating the many difficulties under which the inventor labours. The great expense of taking out patents throughout the world is being taken up with the Controller of the British Patent Office, and already many inventors have cause to bless the Institute for its good offices in bringing them into touch with the right financial group.

"It is perhaps necessary to point out that the Institute in no way clashes with the patent agent; very much the reverse, because the first thing that is done is to instruct the inventor to apply to any good patent agent, and afterwards the Institute, if the particular invention is approved by the Council as being of some use, will work hand in hand with the inventor and will really give him practical help. There is no doubt that such a body, when it becomes better known, will be to the inventor what the A.A. and R.A.C. have been to the motorist for many years.

"The organising secretary is Captain G. Drury Coleman, of 44, Great Russell-street, and we do not hesitate to approach you with this information, knowing that the Institute of Patentees is not a commercial body, but purely what we might term a "Mutual Protection Society."

RESEARCH LECTURES.

WE are informed that the British Non-ferrous Metals Research Association now communicates the results of its research investigations to its members, though lectures are arranged at one or more centres, to which as a rule only the members of the Association itself are admitted. Two objects are served in this manner: first, early confidential communication of the results of the research is assured to those who have given it financial support; and secondly, the investigator gets into close and immediate contact with that section of the industry chiefly interested in his work. The Association is at present engaged on some ten investigations, all of which are closely connected with different branches of the metals and engineering trades.

So far the private lecture system has been applied to two subjects, but the Association has now arranged a third lecture, to be given both in Birmingham and Sheffield by Mr. Dartrey Lewis, M. Met., on his work on "Materials Used for the Abrasion and Polishing of Metals." In view of the wide interests covered, a limited number of tickets is being issued to non-members. The Sheffield lecture was delivered to-day and the Birmingham lecture will be given on Monday evening, February 26th, at 7.30 p.m. Tickets, so far as space permits, can be obtained on written application by firms to the Association's offices, 71 Temple-row, Birmingham.

FARADAY MEDAL.—The Council of the Institution of Electrical Engineers has made the second award of the Faraday Medal to the Honourable Sir Charles Algernon Parsons, K.C.B., F.R.S., honorary member of the Institution. The medal is awarded for "notable scientific or industrial achievement in electrical engineering, or for conspicuous service rendered to the advancement of electrical science."

Engineering Work at Prestwood Sanatorium.

"PRESTWOOD," for many years a fine and well-wooded private estate, was recently purchased by the Staffordshire County Council, and the Staffordshire, Wolverhampton and Dudley Joint Committee has built a sanatorium for consumptives on the site. Three pavilions have been erected, and a new administrative block is in course of construction. The original mansion was to have been used as the administrative centre, but it was burned to the ground a few months ago, and only the basement was afterwards considered fit to be used again under a portion of the new block.

The whole of the buildings have been electrically lighted, and motors have been installed wherever power is required. Heat is provided by a pumped low-pressure hot water system. Domestic hot water is similarly provided, and a vertical steam boiler gives the steam required for laundry and cooking purposes. An interesting fact is that the hot water circulates fairly satisfactorily without the pumps, through the three miles of piping which has been installed, but not sufficiently to give efficient results, unless the pumps be run at frequent intervals, as was, of course, always intended. The mains from the boiler-house to the buildings are laid in a shallow concrete trench with watertight, but removable concrete covering slabs.

A unique feature, so far as this district is concerned, is that 60 brake horse-power are obtained from water power. It appears that, many years ago, the then owner of the estate had a canal formed in order to tap the river Stour at Bell Mill, about two miles distant from the sanatorium. This canal discharges its water over two ornamental waterfalls near the original house, and the second one has been utilised to drive a turbine, the first being converted into an overflow. The turbine—see Fig. 1, page 501—which was supplied by W. Warburton and Co., Limited, is of the reaction type, with a cast iron runner mounted on a horizontal shaft. The guide vanes are of the movable type, perfectly balanced, operating very rapidly, and giving ease and accuracy in governing. The turbine, which is totally enclosed in a steel casing, is mounted on standards on the power-house floor. The test run was very successful and showed that the turbine was developing 65 brake horse-power. The electric generator, which was made by the Rees Roturbo Manufacturing Company, Limited, is coupled direct to the turbine shaft by means of a flexible insulated coupling, which also acts as a fly-wheel, assisting to maintain steady running. The plant is governed by a set of oil pressure type governors acting direct on the guide vanes of the turbine and regulating the flow of water into the runner. In practice very steady running, with not more than 2 per cent. speed variation, is obtained. The turbine, it may be explained, runs unattended through most nights.

The water supply, as already explained, is derived from a canal about two miles long. The water is led directly into a reinforced concrete tank—see Fig. 4—built immediately over the power-house, and passes thence through a short vertical tube into the turbine, from which it is discharged through one elbow and a vertical tube direct into the tail race. From the turbine-house—see Fig. 5—current at 230 volts is conveyed in overhead wires to the engine-room near the sanatorium, and is there distributed as required. The total head of water is about 20ft., and the volume of water per minute passing through the turbine when developing 60 brake horse-power is 2100 cubic feet. The used water finds its way through a tail race 80 yards long back into the river Stour.

Two 40-kilowatt "Falco" electric calorifiers have been installed. They are connected in a by-pass of the domestic hot water circulation system, so that during the night and at such other times as the ordinary load on the turbine will allow, the turbine generator is switched on to the calorifiers and the water is electrically warmed. On such occasions the fire in the wrought iron vertical domestic boiler is allowed to go out. Each calorifier consists of strongly built copper and gunmetal tubular heaters, the tubes being of a special section, on to which standard "Falco" 500 W. heating elements are clamped in pairs. The heat generated in these elements is instantly transmitted to each side of these sectional tubes, which are built in batteries. Each is of 40-kilowatt capacity, so that eighty such elements are installed on the tubes. These elements are constructed of the purest clear mica wound with the very best quality nickel-chrome alloy resistance ribbon obtainable. The elements throughout are wired in parallel across the bus-bars, which are grouped up to the main terminals mounted inside the case. Solid connections are used throughout, and from the main terminals to the double-pole fused ironclad switches, which latter are mounted on the outside of the case. Each of these switches is of 100 ampères capacity and is fool-proof. The outer body is strongly constructed of angle iron, is double cased and lagged with heat insulating material, and is finished off with a grey stove enamel. The whole of the gear was electrically tested under working conditions and submitted to a high-tension flash test of 2000 volts and a hydraulic test before leaving the makers' works. The thermostatic control gear works in series with half the load on each calorifier, so that when the desired temperature is attained 50 per cent. of the load is automatically switched off, but is switched on again at a fixed temperature some degrees below the normal. A Tangye oil engine of 20 brake horse-power—see Fig. 2, page 501—driving a Rees-Roturbo 13.8-kilowatt dynamo, with the necessary switchboard, has been installed as a partial standby to the turbine. A view of the boiler-house is given in Fig. 3, page 501.

Messrs. Henry Lea and Son, consulting engineers, of Birmingham, are responsible for the complete design and supervision of the installation. The turbine work has been carried out by Messrs. Warburton, of Halifax, and the whole of the heating, hot water supply and electrical work has been installed by Henry Hope and Sons, Limited, Smethwick, Birmingham, and of Berners-street, London. The electric calorifiers were made by the Falkirk Iron Company, Limited, Falkirk. The oil engine was made and supplied by Tangyes Limited, Birmingham, and the generators and motors by the Rees Roturbo Manufacturing Company, Limited, Wolverhampton.

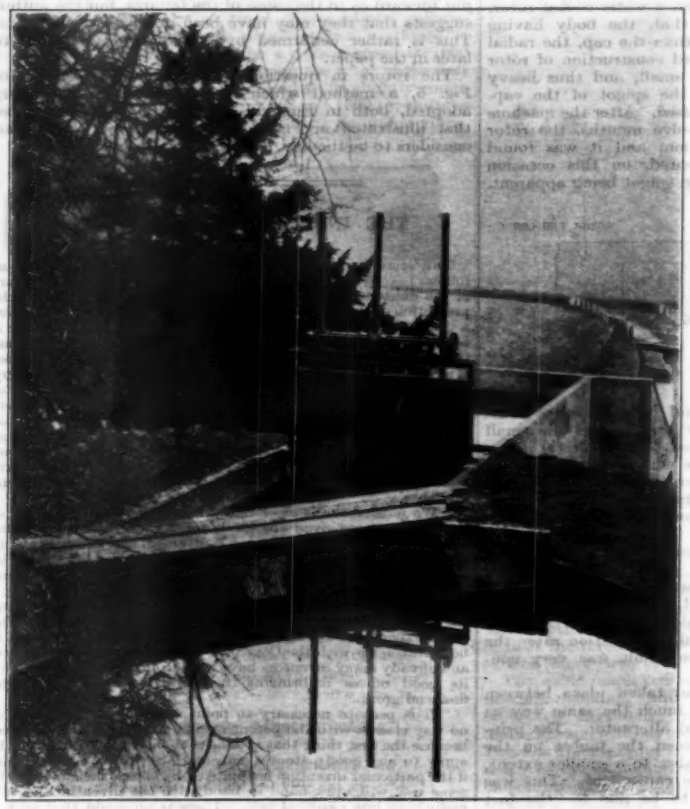


FIG. 4—INTAKE SHOWING SLUICE GATE AND OVERHEAD TANK

FIG. 5—TURBINE HOUSE AND TAIL RACE

The Metropolitan Water Board.

THE nineteenth annual report of the Metropolitan Water Board, which has just been published, and which deals with the year ended March 31st, 1922, shows that during that period the Board supplied a total volume of 91,119.9 million gallons of water, of which 90,418.2 million gallons were supplied in the direct area of supply and 701.7 million gallons to other water authorities in bulk. The daily average supply furnished was 247.72 million gallons in the direct area and 1.92 million gallons in bulk, making 249.64 million gallons in all. The daily average supply per head was 36.27 gallons, representing a decrease of 3.88 gallons compared with the preceding year. The total estimated population supplied by the Board at the close of the year was 6,861,449, representing an increase of 57,885 during the year. Of the total, 4,447,349, or 65 per cent., reside in the area north of the Thames, and 2,414,100, or 35 per cent., south of the Thames.

The effective amount of storage and subsidence reservoir capacity for unfiltered water possessed and in use by the Board at the end of the year was as follows :—

	No.	Area in acres.	Capacity in million gallons.
Thames Valley	31	1,026.5	7,267.5
Lee Valley	17	955.0	5,639.5
	48	1,981.5	12,907.0

The drought of 1921 caused considerable anxiety to the Board, and every effort was made to prevent waste by appeals to the consumers, by reducing the pressure in the mains, and by obtaining a reduction in the quantity of water taken for street watering and other public purposes, as well as for garden watering. Little inconvenience was occasioned to consumers, and the complaints received invariably arose in cases in which the storage cisterns were of insufficient capacity or were absent altogether.

The Chief Engineer submitted, in January, 1922, comprehensive reports setting out the programme of works contemplated by the Metropolitan Water Board (Various Powers) Act, 1921. A schedule showed the expenditure which had already been sanctioned or was likely to be incurred by the Board for works actually in course of construction or immediately to be undertaken. These works included the Littleton reservoir; reservoirs and mains at Bromley, Bickley and Chelsfield; wells and pumping stations at Eynsford and West Wickham; filter beds and pumping station extensions at Walton; the main from Walton to Honor Oak and other works, mains, buildings, machinery and filters. The cost of works contemplated by this programme amounted to over £3,000,000.

The month of maximum average daily supply was June in the Northern, Western and Kent districts, and in the direct area as a whole, and July to adjacent water undertakings. The month of minimum average daily supply was August in the Western, Kent and Southern districts and for the direct area. Taking the grand total supplied by the Board, there was an average daily decrease in the supply furnished during the maximum month of 27,097,600 gallons, or 9.14 per cent., as compared with the preceding year. The difference in the total average daily quantity supplied between the maximum and minimum months throughout the area of direct supply was 32.116 million gallons.

During the year Bills promoted by the conservancies of the rivers Thames and Lee for increasing the payments made by the Board to those two bodies were considered by Parliament. The two Acts received the Royal Assent on August 17th, 1921. The increases in the statutory payments proposed by the Bills and eventually enacted were as follows :—

	Former payment per annum.	Increased payment per annum.
Thames Conservancy—		
Abstraction of water	£45,000	£112,500 as from January 1st, 1921
Lee Conservancy—		
Abstraction of water	£8,000	£20,000 as from June 24th, 1921
Protection of water	£2,000 (max.)	£4000 (max.) as from June 24th, 1921

The following table shows the increases which have taken place under the Board in the equipment of the waterworks

since the transfer to it of the undertakings of the eight original Water Companies :—

	Before June, 1904.	At March 31st, 1922.
Storage reservoirs for unfiltered water	44	48
Acreage of ditto	843	1,981.5
Capacity of ditto in million galls.	4,115.7	12,907.6
Service reservoirs for filtered water	75	91
Capacity of ditto in million galls.	244.5	316.56
Filter beds	137	172
Acreage of ditto	139	170.7
Engines	235	274
Horse-power of ditto	32,177	43,417
Miles of water pipes	5,759	6,577

Copies of the annual report, of which the foregoing is a brief summary, may be obtained from the Board's publication agents, P. S. King and Son, Limited.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Conditions.

THE market situation, speaking broadly, is one of caution. There has been less buying of iron and steel during the past week, but in some measure this is accounted for by the fact that producers of pig iron had little, if any, material to dispose of. Early requirements are, however, pretty well covered, and probably the restraining influences which are at work will make for stability in the long run. It is regrettable that South Staffordshire is not in a position to take full advantage of the trade displacement which is opening up new opportunities for British ironmasters. To this district freer conditions in regard to coke supply and a cheapening of transport are vital considerations. The difficulty of obtaining sufficient coke for the blast-furnaces and the economic question of its price, which is continually hardening, remain as acute as ever. It naturally follows that prices of finished material are moving upward.

Pig Iron.

The pig iron stringency was more pronounced than ever on the Birmingham market to-day (Thursday), and prices as a consequence advanced rapidly. The bugbear of the present position is the fuel situation. Coke is at date practically unobtainable on the open market, and there is no doubt that consumers who are under pressure to buy are paying very much higher prices than prevailed even a short time ago. The competition for coke is such that South Wales producers are able to command 40s. at ovens for the home trade, and they can get more than that in the export market. Prices almost as high were named in the case of South Yorkshire. It is difficult to believe that any furnace owners would think it worth their while to bring additional plant into operation on anything like these terms. It is hoped that the re-starting of some coke ovens now being got ready will relieve the shortage, but fancy prices are being offered by some smelting firms to whom continued production is of vital importance. Could Midland furnaces which have been got ready be re-started, large sales could be made in markets ordinarily served by Cleveland, for Cleveland material is much in advance of Midland prices, in some cases as much as 20s. more being asked. But Midland makers have no iron for sale. They are committed to the full extent of their output for the next few months, partly on account of contracts entered into in December at substantially lower prices. It is now almost impossible to place pig iron contracts for early delivery. The acceptance of a contract is usually followed by urgent demands for early dispatch of metal. These conditions have given Midland smelters an opportunity of further advancing prices, and though values are still much below those of Cleveland, they show substantial increase on last week's figures. Forge material was from 5s. to 7s. 6d. per ton dearer all round, while Northamptonshire foundry commanded an additional 5s. per ton as compared with last week. North Staffordshire irons are now quoted on the same basis as Northamptonshire, viz. :—Forge £4 5s., and No. 3 foundry £4 12s. 6d. ; Derbyshire forge is £4 7s. 6d., and No. 3 foundry £4 12s. 6d. to £4 15s. In many quarters the position is considered abnormal, and there are doubts as to its durability.

Manufactured Iron.

The manufactured iron trade of the Midlands and Staffordshire is still gaining strength. The Staffordshire ironmaster has now brought up his quotations for unmarked bars to the level of those which were ruling in Lancashire and South Yorkshire a week ago. He is now demanding £11 10s. for Crown bars, and in some instances as much as £12. The advance of 10s. per ton by South Yorkshire makers of Crown bars since the last market had a strong tendency to-day (Thursday) to cause a further advance in Staffordshire prices, but it would be incorrect to say that local makers are taking any definite steps at present to level up their quotations to those of the Yorkshire producers. More important than this, however, is the expectation which is now rapidly gaining ground on the Birmingham iron market that a very little further time will see the price of Staffordshire marked bars advanced. For some months past this iron has stood still at £13 10s., which is to-day's figure. With second and third-class bar iron, however, advancing as rapidly as it is now doing, it is impossible that this figure will last much longer. The chances are altogether in the direction of an official advance of £1 per ton, bringing the standard up to £14 10s. in a very short time. Prices of nut and bolt iron have further stiffened. Consumers have largely covered their immediate requirements, but the withdrawal from the market of No. 3 Belgian iron has proved somewhat inconvenient to certain nut and bolt makers who for years past have relied on this material. This has enabled makers in the Midlands to put up their prices, and to-day they are quoting £10 15s. upwards. Lancashire makers have also advanced their quotation to £11 5s., which again puts them ahead of local producers. The substantial advance in pig iron prices is a serious set off, leaving the margin of profit, where it existed, too narrow for the ideas of the manufacturer. More work, however, is being done in South Staffordshire than for many months past. True, new business is not coming in as fast as specifications against contracts made a month or two ago. It is suggested in some quarters that this is a result of the recent advances in prices ; the more probable cause, however, is that consumers have covered themselves for some little distance ahead, and content themselves with specifying against contracts already placed.

Steel—Billets and Bars Dearer.

The steel market is stronger again this week, and quotations for both finished and semi-finished material are higher. Billets have advanced 5s. per ton during the week, being now at a minimum of £8 10s., with some makers asking £9. This further rise in semis has been reflected in higher prices for finished steel, and though the standard price has not been altered, the £9 15s. quotation for small bars has entirely disappeared. It has for some time been regarded as too low, and after going to £10, it has now progressed to £10 10s. or still £1 below the quotation of Lancashire producers. The minimum for Staffordshire hoops is £11 10s. at works, but most quotations are higher, the justification being the high price of billets. The steel works are well booked, and not anxious for further business. Steel scrap is increasingly scarce at £4 5s. to £4 10s. and upwards. It is believed that the shortage will be relieved as more of the steel mills get to work. Foreign competition is not a factor in the situation. For the time being the home maker is in command of his own market, the Ruhr disturbance having put an end to new business with Belgium and France. An unexpected development this week, however, is an offer by Belgian exporters of fairly large quantities of steel strip for tube-making. This has become rather expensive locally, and if the price is attractive these offers may materialise into substantial consignments. A lot of this business was done formerly, both with the Continent and with America. There has been a good deal of talk on various markets as to the threatened repudiation of contracts by continental firms, but nothing has been heard in this district of such developments. Consumers have, however, been warned that in the difficult conditions delayed deliveries must be looked for.

Galvanised Sheets.

The galvanised sheet trade is firm, and mills are well employed, most works having good reserves of orders. Galvanised corrugateds of 24 gauge are being sold at a minimum of £18 15s. Some firms, both here and in South Wales, are quoting up to £19 10s. This country is benefiting by the diversion of orders from Holland and Eastern countries, which nominally would have found their way to Germany. There is a fair inquiry for black sheets.

Improved Conditions in South Staffordshire.

Business at the South Staffordshire works continues to show advancement. Certain large firms are finding that the improvement in orders and inquiries is being maintained fairly well on the whole, and big amalgamations, with subsidiary concerns to supply, have about as much work in hand as they can deal with under the conditions prevailing in the industry at the present moment. The heavy edge tool trade, which has been brightening for some time past, continues to progress. It is reported this week that one of the biggest firms in the district is full up with orders for the next two months, quite apart from present inquiries, and it has been found necessary to start a second night turn, one having been started a short time ago. There are no new markets, but orders are coming along more freely from the Federated Malay States and India, the reason being that orders previously placed by those countries with Germany are not being fulfilled. Prices, it is considered, are likely to appreciate in consequence of the rising steel values, but it is not feared that a rise would have any adverse effect upon the buying movement.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Outlook.

THE markets for iron and steel in Manchester are gradually settling down to the new scale of prices. There is still a good deal of uncertainty as to whether the advances already made will be sustained, and a good many buyers are inclined to wait before making any fresh purchases with a view to testing the stability of the market. The feeling is that the possibilities of a very much larger production in iron and steel are always a threat to the soundness of the markets, and that the trade cannot really be in a sound condition until productive capacity is fully employed. Roughly speaking, the capacity for the absorption of iron and steel is, even now, only about 50 per cent. of the capacity for the output, and this fact alone is sufficient to account for the doubt with which people receive the reports of higher prices and improving trade. Of course, there is one thing which hinders return to full productivity in iron and steel, and that is the shortage of fuel and its high prices, but pessimists ask whether this shortage and these high prices will last. Much depends upon how long it will take the French to re-organise the German industries in the iron and steel district of that country.

Metals.

The non-ferrous metal markets have taken a forward step so far as prices are concerned, but it is not quite clear that this step is justified by any real improvement in trade ; at any rate, in Great Britain. There is certainly no improvement yet in the chances for trade on the Continent ; and the basis of the rise in copper and tin prices seems to be in America only. American domestic consumption of these metals may, and probably will, increase during the course of the present year ; but will this be at the expense of the consuming trades in Europe ? The home demand for manufactured copper and brass seems to be very quiet at present ; but, of course, consumers resent the extravagance of the home prices. There has, however, been more done in refined ingot at the higher prices, and probably there is a greater disposition on the part of consumers to hold larger stocks. Best selected ingot copper is still cheap as compared with electrolytic, but in neither case can the present prices be considered high. Apparently there is some danger to the copper market in the fact that there is a rather large "bull" account in standard, and any untoward happenings might lead to a collapse of this account. One would like to see some surer signs of the revival of trade before placing much reliance on the speculative movement in the copper market, and also some indication that the object of French "sanctions" is not the destruction of the industries of Germany. The market for tin has again been strong, and those who have for months been foretelling a level of £200 for this metal are now more confident than they were. It seems quite possible that this price may be reached, but, if so, it should bring out a good deal more Eastern tin. There is not a very large supply of metal now in our markets, a good deal having been shipped lately to America. There is a steady demand for lead at present prices, but the recent advances in copper and tin do not seem to have had any stimulating effect on lead and spelter. Of course, both these metals are high in comparison with copper prices, and do not need to be forced up any further. The backwardation on forward spelter tends to disappear, and this may be taken as a fairly healthy sign.

Pig Iron.

The market here for pig iron is very firm, but there does not seem to be very much new business about. Apparently both buyers and sellers are dissatisfied about the prices, the former thinking that, so far as the foundry trade is concerned, there is no proper justification for dearer iron ; and the latter thinking that, so far as the prospects of increased costs are concerned, the prices in the Midlands have not yet risen sufficiently. This incompatibility of views is hindering business, and it is very difficult to say who is in the right. Cleveland iron is very scarce, and the prices for any small lots available have risen to extreme figures. In fact, a Cleveland furnace can get about 20s. per ton more for its iron than a Midland furnace ; and the quality is practically equal. There is still some prompt Derbyshire No. 3 pig iron to be had here at about 100s. per ton delivered, although some makers are asking 102s. 6d. For far forward delivery, say over the second quarter of the year, makers seem unwilling to quote, so there is very little forward business being done. Scotch and hematite iron are dearer here, but there is not much difference. Scotch is quoted at 122s. 6d. to 125s. per ton delivered, and East Coast hematite would cost a little less ; but there is only a small business now being done here in these irons, most ironfounders thinking them too dear.

Steel.

The market for manufactured steel here is firm, and the Midland makers seem to have more work in hand than some of those in Scotland and on the East Coast. This is perhaps the reason why prices in those districts are so much more irregular than they are here. One sees steel plates, for instance, quoted at £9 5s., and sometimes at £9 2s. 6d., whereas here the usual quotations are from £10 5s. to £10 10s., and up to £10 for sections. There would seem to be very little competition now from the Continent ; and the absence of any foreign semi-steel has strengthened billets here, so that they are now inconveniently dear. Some of the Midland works are quoting over £8 for rolling billets.

Scrap.

The demand for scrap materials is certainly better than it was. Steel scrap is quite scarce, and dealers here are now trying for 80s. per ton on trucks. Heavy wrought scrap is in good demand at about 85s. per ton. Foundry scrap is still too plentiful, but the advance in pig iron has strengthened the idea of dealers, and they are now unwilling to accept any low prices. Good broken machinery cast iron can, however, still be bought at 87s. 6d. to 90s. per ton.

Manchester Ship Canal.

The report of the directors of this undertaking for 1922 is by far the most satisfactory that has hitherto been published. The sea-borne traffic handled during the year was no less than 4,081,571 tons, compared with 3,117,469 tons in 1921. The barge traffic also showed a slight increase over the previous year, amounting to 191,973 tons, making the total tonnage 4,273,544. The total receipts were the second highest in the history of the undertaking, being 1,332,490, an increase of £135,415 over those of 1921. On the other hand, the working expenses were reduced by £78,527, owing to decreases in stores, materials, and wages. Among the items of expenditure on works the largest item is one of £112,179 for dredging, while £66,300 was spent during the year on repairs of locks, roads, bridges, &c. The westerly berths for tying-up vessels above Eastham Locks are being deepened, in order to improve the accommodation. Dredging to provide a further extension of the turning basin in the Ship Canal at the mouth of the river Weaver, has been carried out. The berths at the North Quay, Ellesmere Port Docks, have been deepened and extended to provide accommodation 1200ft. long, with a depth of water of 28ft. The new dock, subway, and other works on the Ship Canal at Stanlow, near Ellesmere Port, were brought into use for the importation of petroleum products in June last. The contract for the construction of a reinforced concrete wharf—including foundations for transit sheds—adjoining Trafford Wharf-road, at the Manchester Docks,

is in progress; the works are about halfway towards completion.

New Manager of Beyer Peacock's.

Messrs. Beyer, Peacock and Co., the well-known locomotive and machine tool builders, Gorton, have appointed Mr. Robert Harben Whitelegge, general manager. Mr. Whitelegge will take over his duties on March 1st. Before the grouping of the railways Mr. Whitelegge was chief mechanical engineer of the Glasgow and South-Western Railway. He is president of the Institution of Locomotive Engineers.

Linking-up of Electricity Undertakings.

The Preston and Blackburn Town Councils have come to an agreement whereby the electricity undertakings will be linked up.

BARROW-IN-FURNESS, Thursday.

Hematite.

The hematite pig iron trade continues to be very active, and there is no falling off in inquiries or orders. All the makers are proceeding cautiously and are not rushing fresh furnaces into blast until they are quite sure of the market. Prices continue to stiffen, and this tendency will remain unless there is a falling off. Some of the makers are embarrassed by the shortage of coke, which is not coming through as fast as it should owing to there being heavy shipments abroad. As a result of the shortage the Millom works have been compelled to damp down three furnaces for several days until fresh supplies came to hand. This is unfortunate, for there need be no interruption, especially in the case of Millom, which is fully booked up. There is the usual amount of iron being shipped to the Continent and from local ports to Scotland and South Wales. The Midlands are now big customers and are ordering well forward.

Iron Ore.

The iron ore trade continues to improve, and many mines are experiencing better business than they have for a considerable time. There is not a great amount going out of the district. Prices are inclined to harden. Foreign ore is not coming in large quantities yet, but there will be an improvement in imports shortly.

Steel.

The steel trade is fairly good, and the rail mills continue to work and will do so for some time yet on orders held. Workington mills are engaged, but it is not known if they have orders to carry them over many weeks. The hoop mills at Barrow are active, and the foundries are experiencing better trade. There have been shipments of rails and hoop iron from Barrow to Liverpool for transhipment abroad. There is a constant demand for scrap by steel makers, and the supply is not a very good one.

SHEFFIELD.

(From our own Correspondent.)

Boom in Heavy Steel.

CONDITIONS in the pig iron and heavy steel trades may now be described as of the boom variety. The scarcity of pig iron is serious, and there is a great need for the products of further furnaces, but, unfortunately, the necessary coke for firing them cannot be obtained. A very large tonnage of steel billets is being turned out, and is going direct into consumption, which is evidence of much manufacturing activity in various parts of the country. The Templeborough works of Steel, Peech and Tozer, Limited, which were not in existence before the war, are now producing about 6000 tons of steel per week. A large new open-hearth furnace was started at these works last week, and another at the Penistone works of Cammell Laird, and Co., Limited. The higher prices of steel and manufactured iron, which have been shown in your weekly lists, are firmly held, and there has been a considerable advance in blast-furnace coke. Sheffield will benefit from a large order for electrical plant which has been placed with the Metropolitan-Vickers Company by the Japan Electric Light Company, of Osaka. The order is for turbo-generating plant amounting to 50,000 kilowatts, and it is understood that the value of it is about £100,000. Most of the work will be done at Trafford Park, Manchester, but the big forgings will be made in Sheffield.

The Railway Departments.

There is still an excellent tone in the departments manufacturing railway supplies, such as springs, axles, tires, and buffers, and recent optimistic forecasts are being justified. Both the home railway companies and private wagon owners are placing orders every week, and there is hope of an early revival of overseas buying, especially on the part of India and South America. The local plants are so extensive, and their means of production so expeditious that it will take a very great amount of work to keep them fully employed. Prices of material continue low, and there are reports of orders for wagons being placed at figures which can hardly be called remunerative. John Baker and Co., Limited, of Rotherham, who are largely engaged in railway work, have issued a circular to their shareholders, explaining that they are unable to pay the preference dividend on account of last year's slump. They add that the last two months have seen a greatly increased demand for their manufactures. As yet, prices are very low, but the directors hope there will shortly be an improvement in this respect.

Other Steel Departments.

There is a considerable increase in the amount of work on hand at the rolling mills, while the forges are booking enough to keep them well employed. In the finished branches of the steel trade less progress is being made. There is some improvement in crucible steel, and the outlook is encouraging, but the movement has not gone very far yet. For engineers' small tools, files, and a variety of other products, demand is slow, and in some cases trade is said to have fallen off markedly since the beginning of the year. The decline is probably due, to some extent at any rate, to reduced purchasing by France and Belgium, on account of the depreciation of the exchange. Although, on the whole, it is possible to go on giving cheering reports of the progress of the city's trade, this does not mean that there is no slackness. On the contrary, the total number of unemployed in the city still remains terribly high. The reduction of 858 last week was the largest recorded for several months, but the number of names remaining on the registers of the employment exchange is no less than 33,454.

Electric Rolling of Steel.

The Tinsley Rolling Mills Company, Limited, has just installed a new electrically driven mill for the rolling of spring steel and strip. A visit was paid to it last week by representatives of the Springs Committee of the Government Department of Scientific and Industrial Research, and also of the Research Association of British Motor and Allied Manufacturers. It is recognised as being one of the most up-to-date and efficient plants of its kind in the country. It is driven by a motor of 500 horse-power and a 10-ton travelling crane is also operated by electricity. On the occasion of the visit, spring steel was rolled in lengths of 60ft., and the accuracy with which the mill produced the finished material was specially noticeable. The furnaces are of the modern continuous type. A railway siding is carried to the inside of the mill, and coal is delivered by the canal which runs past the works.

Cutlery and Plate.

There is much unevenness in the distribution of work in the cutlery trade. While some firms are very busy, especially in the table knife department, others are badly placed for orders. Australia is a good market, and the Canadian demand is improving, though but slowly. American competition in the cheaper classes of cutlery is very severe. There are still large stocks of German pen and pocket knives in this country, which are seriously affecting the sale of the home product, although the new importations of German goods have fallen away very greatly. This branch of the Sheffield trade is being improved by the introduction of modern mechanical methods of manufacture. The plate trade is moderately well employed. Masters and men have agreed on a stabilisation of wages for twelve months, and it is hoped that this settlement, by showing that prices have fallen as low as they are likely to, will induce consumers to send in orders which they have been holding back while negotiations were in progress. Spoons and forks plated with chromium are now being offered for sale.

Sheffield Road Schemes.

The Sheffield Corporation is making good progress with the construction of new roads and other works, for relief purposes, on which it has been engaged continuously since December, 1920. The largest scheme on hand at present is a road from Owlerton to Norwood, on which about 1500 men, drawn from the ranks of the unemployed, are engaged. The work is nearing completion, and about two months hence it will be finished with the exception of the permanent surfacing of the road. Altogether, about 2100 relief men are being found work by the Corporation at present, and of these 80 per cent. are ex-Servicemen. A start has been made this week with the widening of Owlerton Bridge, which takes an important road over the river Loxley. The work is being pushed forward in readiness for the Yorkshire Agricultural Show, which will be held in Hillsbro' Park, Sheffield, in July, and which will involve a great amount of traffic over the bridge. The cost of the widening will be £12,000. A similar sum is to be spent on the widening of Leppings Bridge, also in the same district of the city, and £5000 on Staniforth-road canal bridge, Darnall. Among the works to be started by the Corporation during the year are the new intake to Gleadless-road, which will cost about £40,000; the remainder of the Abbey-lane improvement, £15,000; and the Fulwood tramway extension, £15,000.

Derbyshire Projects.

I have previously referred to the important scheme for reclaiming river land which has been brought forward at Derby. The Derby Chamber of Commerce is now urging the Corporation to include this in a town-planning scheme which it has before it. It is not suggested, however, that the scheme should be proceeded with at present, but only that the preparations should be made. The Chapel-en-le-Frith Rural District Council is faced with a scheme for remodelling the sewage outfall works at Chinley. The Ministry of Health is insisting on either remodelling or the treatment of the sewage elsewhere. The Council has decided on the remodelling plan, which will cost £7600, and which it considers will save it £200 in comparison with an alternative scheme suggested by the Ministry.

NORTH OF ENGLAND.

(From our own Correspondent.)

Eight-hour Day Proposal Rejected.

THE Cleveland ironstone mining industry, the future prosperity of which depended in a large measure upon a reversion to the working hours in operation prior to the passing of the Mines Act in 1919, is now faced with a grave situation, the miners by a narrow majority of 130 votes having rejected the mineowners' proposal to revert to the eight-hour day. The result was announced at a joint conference of the owners' and men's representatives this week, and although further discussions took place with a view to an amicable settlement being reached, no progress was made. Recently, the owners pointed out that the pressure of competition from outside had become very severe, and unless wages and conditions in the area could be so adjusted as to enable ore to be produced at a cost which would induce the ironmasters to use it in preference to ores from other districts and from overseas, the bulk of the Cleveland mines must remain idle, while some of the mines now in operation might have to be closed down again. The mineowners offered as an inducement for longer hours certain increases on the base rate wages of lower-paid datal men, and also offered to take into consideration other questions affecting wages.

Cleveland Iron Trade.

Business in the Cleveland iron trade has virtually ceased. Prompt supplies are almost unobtainable, and there is a general indisposition to enter into forward contracts. Consumers naturally hesitate to follow the phenomenal rise in pig iron values which has taken place during the past few weeks, and producers, faced with the ever-increasing cost of ore and coke, are equally reluctant to commit themselves far ahead, for a profitable figure now may represent a heavy loss a week or two hence, so uncertain is the state of the market in raw materials. The whole position is prejudiced by the scarcity and high price of furnace coke. Coke producers on the North-East Coast are having to submit to a constant clamour for supplies. They are selling to local ironmasters at a preferential rate, but even so their price continues to rise, and now the generally quoted figure for good Durham blast-furnace coke delivered at the works has advanced to 37s. 6d. per ton, a rise of 8s. 6d. since the beginning of the year. Ironmasters need big prices for their iron to pay such charges for fuel, but most of the current make is being delivered at prices which on present costs of production must be unremunerative. Order books are now well filled for March and April, and only an occasional odd lot of foundry iron comes on to the market. For these small lots of the standard No. 3 quality 115s. per ton is the generally accepted figure, whilst No. 1 is nominally at 117s. 6d. No. 4 foundry is about 110s., and siliceous iron is offered at 115s. There is no No. 4 forge, mottled or white iron on the market, most of the output of these qualities having been used in the local steel furnaces.

Hematite Pig Iron.

Supplies of hematite pig iron are also running short and makers have little iron to offer, having sold extensively over the next two months. Mixed numbers are quoted at about 110s. per ton.

Iron-making Materials.

A rather active market is reported in foreign ore—chiefly North African and South Spanish ores, which are relatively cheaper than best Rubio. Good sales are reported, and there are more inquiries about. But for best Rubio there is little demand, and 25s. per ton is purely a seller's price.

Manufactured Iron and Steel.

In the manufactured iron and steel trade business is not very brisk, but works are now fairly well employed. Manufacturers aver that the Ruhr occupation, and the consequent decline in continental production, have not produced any increased demand for British steel, but, on the contrary, have prejudiced the position by driving up the price of fuel and consequently the cost of production. Fairly large quantities of blooms and billets have been sold, but the price only represents bare cost, and production costs are rising so rapidly and the outlook is so uncertain that steel makers hesitate to undertake forward contracts at present prices. Steel rails and fish-plates have been advanced 10s. per ton, and in all cases where long hauls are necessary, the extra cost of transport is added.

The Coal Trade.

The Northern coal trade is now in an exceptionally strong position as regards orders, and there is a marked scarcity of supplies of every kind. Though the stormy weather on the coast is playing havoc with shipping movements, causing great delay in the arrival of steamers and dislocating the loading turns—a fact which often releases a cargo for sale—there is scarcely any fuel available for the next few weeks. This undoubtedly presages a further advance in prices. Last week's quotations rule all round; but they are strongly indicated without concession of any kind, and it would occasion no surprise if a further leap forward in values were announced. Among the latest prices paid have been 28s. per ton for best steams and similar, with 26s. for unscreened for bunkers. In Durhams good ordinary brands of coking coals have been contracted for several times over in large quantities at 30s. per ton f.o.b., with shipment from March to the end of June. In second gas 27s. has been paid f.o.b. prompt, while 26s. 6d. is freely offered for April to June shipment. These actual transactions show the strength of the coal position at the present time, and if current indications are any guide to future probabilities, it looks as if the market will not only hold for a few months ahead, but may even move further. Those who take a roseate view—from the colliery standpoint—of the situation base their optimism on the continuance of the abnormal demand from Germany, which has been accentuated by the French occupation of the Ruhr region. They contend that a very large portion of the output from German collieries has already been lost by the upheaval, and that at the very best it will take months to recover lost ground, so that coal from England will be a prime and urgent necessity for months to come. The demand from Germany continues to be exceptionally heavy; in fact, the clamour for coals for there is greater than ever it was. French buying is a little heavier, while Italy and the Scandinavian countries, which have been and are still buying only from hand to mouth, are expected to come into the market for much larger quantities in the course of the next few weeks. The coke market is exceedingly strong, with supplies running shorter, and values moving in an upward direction for all sorts of foundry makes. Gas coke is very steady.

SCOTLAND.

(From our own Correspondent.)

The Higher Prices.

OPINIONS differ as to the immediate effect of the general increase in prices of steel, iron, and coal. On the one hand, it is stated that the recent development of trade has already been retarded, while on the other, it is said that business is as brisk as ever, and that prices may go higher yet without having any adverse effect on the growth of trade. Higher oncosts have necessitated certain increases in quotations of finished materials, and so long as certain competitors are practically out of the market, further increases might with safety be imposed; but in the opinion of many producers the policy of adhering to the lowest possible scale of charges is the safest basis to work on. The situation on the Continent has undoubtedly influenced the position here, but an alteration in the conditions governing the first named would soon cause a decided reaction in home markets if prices are allowed to soar. Overseas buyers are already acting with greater caution, and financiers will require to go warily if the ground gained is to be held.

Pig Iron.

The outlook in the pig iron trade is brighter. Makers have good home demands and have some difficulty in meeting all calls owing to the small number of furnaces in blast. Still higher prices may, therefore, be looked for. Continental and American buyers, too, are again in the market, but so far exports have been small in bulk.

Steel and Iron.

The steel and iron markets have been comparatively active throughout the past week. Transactions have been fairly numerous, but there is certainly less inclination to anticipate future requirements; neither producers nor buyers are prepared to risk much. At the same time, arrangements are still being proceeded with to increase the output of raw materials as well as finished steel and iron. Various works in the Lanarkshire area are being either restarted or more fully equipped, and the outlook in the district is very promising. The steel works are better employed on ship plates and sectional material, and steel makers have added to their recent bookings by a better demand for heavy material for abroad. Sheet mills are all busy, but the position could be further improved if sheet bars were in better supply. Business in bar iron continues to develop. The home demands are steady, and export inquiries are growing gradually to a considerable tonnage. Re-rolled steel makers have plenty of orders for bars, tube strips, &c.

Coal.

There has been no change of importance in the Scotch coal trade since last week. Export demands continue as strong as ever, and any available supplies are quickly disposed of. The collieries are already heavily booked up for almost all classes of fuel, and prices for prompt lots are rather firmer, while quotations for future delivery are much higher and, in fact, are said to be prohibitive. West of Scotland ells and splints are particularly busy, and shipments are fairly prompt, but the loading conditions on the East Coast are not so favourable, a loading turn of several days being the rule. Fifeshire and Lothian steams are heavily sold, and smalls in all districts have done a big turnover. Aggregate shipments amounted to 325,113 tons, against 302,132 in the preceding week, and 208,095 tons in the same week last year. In the home market the demand centres round municipal, railway, and household requirements. Ordinary industrial demands are comparatively light.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THERE is not a great deal of change in the steam coal trade as compared with a week ago. Prices are being well maintained despite the adverse factors that have to be contended with, such as the slow working at the docks and the delay in the clearance of wagons resulting in irregular work at many of the collieries. The surprise is that the market is so firm, though in the case of small coals it naturally follows that as the working at the pits is not regular and less large coal is being turned out, the supply of smalls is reduced. The demand for small coals, especially coking qualities, is extremely active. The inquiries come from France, Belgium, and Germany, and it is stated that people acting for Germans are ready to buy anything that they can pick up in the way of small coals, while there is also an inquiry for 20,000 tons of large coal, which is stated to be for German Government account. The French State Railways are open for 30,000 tons of large and small coals, but in the case of the recent inquiry from the Belgian State Railways for 56,000 to 80,000 tons of smalls, it is reported that the prices which were tendered have not been accepted, as they were considered to be too high. The demand from the private importer abroad is not very brisk, and this fact is attributable to the adverse exchange rates prevailing; but at the same time continental railways with contract coals to lift, principally the French railways, are speeding up their shipments, which indicates that France is not getting the quantity of coals from the Ruhr that was expected. It is also significant that the Italian State Railways have lately bought substantial supplies of coal and within the past few weeks tonnage has been chartered to take not far short of a hundred thousand tons from South Wales. The result is that collieries have not much coal to spare for the next few weeks, and they are quoting very firmly for supplies ahead, although for prompt loading many of the collieries are still continuing to meet with difficulty because they cannot get their tonnage into berth, and are compelled to reduce their price to some shipper who can take immediate delivery and enable the colliery to get empty wagons.

Working Hours at the Docks.

Non-success has attended the efforts to arrive at a satisfactory conclusion as regards the hours of work of trimmers and tippers at South Wales ports, and, as a consequence, the employers have decided to apply to the Industrial Court in conformity with the finding of the court in 1920, viz., "that there be reserved to the employers the right to claim that a third shift be put on should the requirements of the trade warrant it." During last week-end the proposals of the employers for extended hours of working during the two shifts in existence were submitted to mass meetings of the tippers and trimmers; but it was scarcely expected that these meetings would approve of the proposals in view of the fact that their leaders had intimated that they would recommend the workmen not to accept them. As a matter of fact, the mass meetings declined to entertain the employers' scheme, but they empowered the leaders to put forward, as they stated, "to test the good faith of the employers," counter proposals regarding the possibility of the application of a partial third shift for an experimental period of three months, provided that such addition should be made to the tariff payments as would safeguard the earning power of the men. When the conference of all parties interested took place on Monday last the men's leaders submitted this proposal; but the employers were not prepared to alter the tariff or to guarantee the maintenance of the present earnings per shift, with the result that the conference was abortive. It is very unfortunate that this was the case, as it is impossible to say when the court of inquiry will be held, though the Ministry of Labour is to be asked to ensure that there shall be no delay. The need for immediate action to remedy the present conditions at the docks is urgent; but the position is that the trimmers, whose earnings are pooled, are afraid that by the employment of an increased number of men they will not be able to draw from the pool as much as they are doing under the present conditions, and they want the employers to safeguard them against such a contingency. Furthermore, they are opposed to working more than a forty-four hour week as against a forty-eight hour week, which the proposal of the employers involved when they suggested extending the two shifts at present in operation.

Current Business.

There has been a good deal of inquiry on the market, but the proportion which results in actual business is comparatively small because many consumers abroad find the prices comparatively high. Apart from the fact that coal prices are firm, rates of freight have advanced perceptibly during the past week or so, which, of course, is very welcome to shipowners, but does not assist to get business through seeing that the c.i.f. price is increased. At the same time collieries are well sold ahead, and for the small quantities of best Admiralty large, which can be booked up for March shipment, collieries are quoting from 29s. 6d. to 30s., while seconds are firm at 28s. 6d. to 29s. Monmouthshire coals are very steady, without much appreciable alteration in values, but dry qualities are a shade better than they were a week ago. The feature of the market, however, is the strength of small coals, and for the best steam descriptions, colliery salesmen are quoting from 22s. to 22s. 6d., while inferior grades are very steady at 17s. to 18s. There is no change in the patent fuel trade, as supplies of pitch are still scarce. Makers decline to quote for supplies ahead. Coke is a strong market. In the anthracite section large coals and nuts and cobbles are quiet for prompt shipment, but beans, rubbly culm and duff coals are scarce and prices are firm.

Colliery Developments.

THE Powell Duffryn Company is making rapid progress with the pit sinking at Llanharan. The new pit has been sunk to a depth of 280 yards, and the old pit, which was reopened by the company, has been sunk now to a depth of 420 yards. Fine seams in both pits have been passed, but the company intends sinking to the steam coal measures and working the other seams later.

Swansea Metal Exchange.

The tin-plate market is firm, though business is rather quieter. Makers are getting somewhat anxious owing to the rapid advance in the price of tin, and if this continues it is expected that tin-plates will advance.

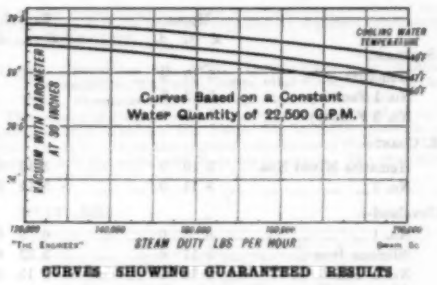
Non-Unionism.

Trouble on the non-unionist question is increasing in the coalfield, and stoppages at collieries have taken place in the Gwendraeth Valley. On Wednesday morning about 600 men at the house coal colliery of the Powell Duffryn Company struck work, and unless the situation improves quickly, the trouble is likely to extend throughout the Rhymney Valley. There is also a stoppage at the Nine Mile Point collieries on the same question, the miners being in conflict with members of the Mechanical and Surface Workers' Union.

Condensing Plant Tests at Dalmarnock.

IN our issue of July 21st, 1922, we described the surface condensing plant installed by the Mirrlees Watson Company, Limited, at the Dalmarnock Electricity Works of the Glasgow Corporation. The turbine and alternator of the No. 5 set were built by the English Electric Company, Limited, and the plant is normally rated at 15,000 kilowatts with an overload capacity of 18,750 kilowatts. The steam duty of the condensing plant is 161,500 lb. of steam per hour at a vacuum of 29.1in. of mercury (barometer 30in. and with cooling water at a temperature of 50 deg. Fah.)

With the consent of the Glasgow Corporation engineer and under his supervision, the Mirrlees Watson Company, Limited, has recently carried out some tests on the No. 5 surface condenser, particulars of which we give in the following table. The official tests of the plant will, we understand, take place at a later date.


COOLING WATER TEMPERATURE
Curves Based on a Constant Water Quantity of 22,500 G.P.M.
VACUUM WITH BAROMETER AT 30 INCHES
STEAM DUTY LBS PER HOUR

CURVES SHOWING GUARANTEED RESULTS

The condenser is wedge shaped and has 26,000 square feet of cooling surface. The air pump equipment comprises two groups of Mirrlees-Leblanc "Simple Type" steam ejectors, each of which is designed to deal with the full-load duty of the plant. The two groups of ejectors are connected to an air suction main and every ejector is provided with an isolating valve, so that the number of ejectors in operation at any one time may be varied according to the load and the condition of the plant as regards air leakage. This arrangement ensures the maximum economy of working. There are two condensate pumps, one being a standby, and each pump is designed to extract 400 gallons of condensate per minute and deliver it to a Lea recorder placed on the turbine floor level at a height of 30ft. above the pump level. From the Lea recorder the water flows to a feed-water heater, from which it is again pumped through a height of 75ft. to the hotwell tanks. A lift pump—also in duplicate—is provided for this purpose, and the lift pumps and condensate pumps are combined in one set and are directly driven by an electric motor developing 37 brake horse-power at a speed of 1440 revolutions per minute.

The curve we reproduce above illustrates the guarantees given to the Glasgow Corporation.

Table showing Results of Test of Condensing Plant.

Test number.	Barometer in inches of mercury.	Vacuum at turbine exhaust.	Absolute pressure at turbine exhaust.	Temperature of circulating water in degrees Fah.		Condensate temperature in degrees Fah.	Steam condensed in lb. per hour.	Circulating water in gallons per minute.
				Inlet.	Outlet.			
1	29.86	29.26	.6	47	55.8	55	143,000	22,500
2	29.86	29.15	.71	47	61.5	56	180,000	22,500
3	29.85	29.16	.69	47	61	56	180,000	22,500
4	29.84	29.14	.7	47	61	56	180,000	22,500
5	29.84	29.12	.72	47	61	56	180,000	22,500
6	29.84	29.15	.69	47	60.5	56	180,000	22,500
7	29.84	29.3	.54	47	57	53	123,000	22,500

LAUNCHES AND TRIAL TRIPS.

BOMPATA; built by Harland and Wolff, Limited; to the order of Elder Dempster and Co., Limited; dimensions, 425ft. by 54ft. by 31ft. 6in.; to carry 5500 tons. Engines, double reduction geared turbines; constructed by the builders; trial trip, January 16th.

INVERAVON, "N" type standard vessel; built by Harland and Wolff, Limited; to the order of the British Mexican Petroleum Company; dimensions, 428ft. by 55ft. 3in. by 38ft.; gross tonnage 6900. Engines, triple-expansion; constructed by the builders; launch, January 18th.

CHELURA, twin-screw 1500-ton hopper dredger; built by Wm. Simons and Co., Limited; to the order of the Bombay Port Trust. Engines, triple-expansion, pressure 185 lb.; constructed by the builders; launch, January 19th.

BRITISH FUSILIER; oil tanker; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the British Tanker Company, Limited; dimensions, 455ft. by 57ft. beam; to carry over 10,000 tons of oil. Engines, turbines of Metropolitan-Vickers Rateau type; constructed by the builders; trial trip, January 28th.

BRITISH CAPTAIN, geared turbine oil tank steamer; bulir by Palmer's Shipbuilding and Iron Company, Limited, to the order of the British Tanker Company, Limited; dimensions, 440ft. by 57ft. by 33ft. 11in.; 10,200 tons deadweight. Engines, single-screw double reduction geared turbines, pressure 200 lb.; constructed by the builders; trial trip, February 1st.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	21/6
(1) Spanish	21/6
(1) N. African	21/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	25/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 10 0	—
No. 1 Foundry	5 12 6	—
No. 3 Foundry	5 7 6	—
N.E. COAST—		
Hematite Mixed Nos.	5 10 0	5 10 0
No. 1	5 11 0	5 11 0
Cleveland—		
No. 1	6 0 0	6 0 0
Silicious Iron	5 17 6	5 17 6
No. 3 G.M.B.	5 15 0	5 15 0
No. 4 Foundry	5 10 0	5 10 0
No. 4 Forge	5 7 6	5 7 6
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	4 12 6	—
,, ,, Foundry	4 10 0	—
(3) Northampton—		
Foundry No. 3	4 12 6	—
,, Forge	4 5 0	—
(3) Derbyshire—		
No. 3 Foundry	4 12 6 to 4 15 0	
Forge	4 5 0 to 4 7 6	
(3) Lincolnshire—		
Basic	5 5 0 to 5 10 0	
Foundry	4 10 0 to 5 0 0	
Forge	4 5 0 to 4 10 0	
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 17 6	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 0 0	10 10 0
Best ,,	12 0 0	—
N.E. COAST—		
Crown Bars	11 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	12 0 0	—
Second Quality Bars	11 5 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 0 0	—
Best ,,	12 10 0	—
Hoops	15 0 0	—
MIDLANDS—		
Crown Bars	11 10 0	—
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	10 15 0	—
Gas Tube Strip	10 15 0 to 11 0 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 0 0	—
Ship Plates ¼in. and up	9 5 0	—
Sections	9 0 0	—
Steel Sheets ¼in. to ⅛in.	11 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	19 0 0

STEEL (continued)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 10 0	—
Angles	9 0 0	—
Boiler Plates	13 0 0	—
Joists	9 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 10 0	—
Channels	9 5 0	—
Hard Billets	8 15 0	—
Soft Billets	8 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 0 0	—
Light ,,	10 0 0 to 10 10 0	
Billets	9 0 0	—
MANCHESTER—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	14 15 0	14 10 0
,, (Soft Steel)	12 15 0	12 10 0
Plates	9 0 0 to 10 0	
,, (Lanca. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	9 5 0	—
Intermediate Basic	9 0 0	—
Soft Basic	8 15 0 to 9 0 0	
Hoops	12 15 0 to 13 0 0	
Soft Wire Rods	10 10 0 to 11 10 0	
MIDLANDS—		
Small Rolled Bars	10 0 0 to 10 10 0	
Billets and Sheet-bars	8 10 0 to 9 0 0	
Gas Tube Strip	10 5 0 to 10 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	18 15 0 to 19 10 0	
Angles	9 15 0	—
Joists	9 15 0	—
Tees	10 15 0	—
Bridge and Tank Plates	9 15 0 to 10 0 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	21/- to 21/6
Block Tin (cash)	191 10 0
,, (three months)	193 10 0
Copper (cash)	69 0 0
,, (three months)	69 15 0
Spanish Lead (cash)	28 7 6
,, (three months)	28 5 6
Spelter (cash)	36 0 0
,, (three months)	36 2 6
MANCHESTER—	
Copper, Best Selected Ingots	74 0 0
,, Electrolytic	76 0 0
,, Strong Sheets	98 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 1 0
,, Condenser	0 1 1½
Lead, English	29 10 0
,, Foreign	28 10 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23	10/6
,, 6 p.c. to 8 p.c. ,,	£21 0 0	8/-
,, 8 p.c. to 10 p.c. ,,	£20 0 0	8/-
,, Specially Refined ,, Max. 2 p.c. carbon	£54 0 0	20/-
,, ,, 1 p.c. ,,	£64 0 0	22/6
,, ,, 0·75 p.c. carbon	£72 0 0	25/-
,, carbon free	1,6 per b.	
Metallic Chromium	4/6 per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£11 15 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 0 0 scale 6/- per unit	
,, Vanadium	17/- per lb.	
,, Molybdenum	9/- per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£130	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	26/-
,, ,, Ell	27/-
,, ,, Splint	28/- to 30/-
,, ,, Trebles	26,6
,, ,, Doubles	25,6
,, ,, Singles	24/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	26/-
,, ,, Splint	28/-
,, ,, Trebles	26,6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	26/- to 27,6
Screened Navigation	32/-
Trebles	27/-
Doubles	25/-
Singles	24/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	26,6
Secondary Steam	25,9
Trebles	27/-
Doubles	25/6
Singles	25/-

ENGLAND.

(8) N.W. COAST—	
Steams	29/-
Household	46/8 to 57/6
Coke	36/-
NORTHUMBERLAND—	
Best Steams	29/- to 30/-
Second Steams	27 6 to 28/-
Steam Smalls	18/- to 20/-
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	29/- to 30/-
Second	27/- to 28,6
Household	25/- to 28/-
Foundry Coke	65/- to 70/-

SHEFFIELD—	INLAND.
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	25/6 to 27/6 —
,, ,, House	23/- to 24/6 —
,, ,, Large Nuts	20/6 to 22/6 —
,, ,, Small ,,	15/- to 16,6 —
Yorkshire Hards	21/- to 22/- —
Derbyshire ,,	20/- to 21/- —
Rough Slacks	9/6 to 11/- —
Nutty ,,	7/9 to 9/9 —
Smalls	3/- to 5/- —
Blast Furnace Coke (Inland and Export)	23/- to 30/-

CARDIFF— (9) SOUTH WALES.	
Steam Coals:	
Best Smokeless Large	29/- to 30/-
Second ,, ,,	28/6 to 29/-
Best Dry Large	27/6 to 28/6
Ordinary Dry Large	26/6 to 27/6
Best Black Vein Large	28,6 to 29/6
Western Valley ,,	28/- to 28/6
Best Eastern Valley Large	27/6 to 28/-
Ordinary ,, ,,	27/- to 27/6
Best Steam Smalls	22/- to 24/6
Ordinary ,,	17/6 to 20/-
Washed Nuts	25/- to 30/-
No. 3 Rhondda Large	29/- to 30/-
,, ,, Smalls	20/- to 21/-
No. 2 ,, Large	26/- to 27/-
,, ,, Through	21/6 to 23/-
,, ,, Smalls	18/- to 19/-
Coke (export)	55/- to 60 -
Patent Fuel	35/- to 37/6
Pitwood (ex ship)	26/6 to 27/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	35/- to 37/6
Seconds	30/- to 32/6
Red Vein	27/6 to 28/6
Machine-made Cobbles	40/- to 45/-
Nuts	50/- to 52/6
Beans	45/ to 47/6
Peas	20/- to 22/-
Breaker Duff	11/- to 12/-
Rubbly Culm	14/- to 15/-
Steam Coals:	
Large	26/- to 27/-
Seconds	23/- to 25/-
Smalls	15/- to 16/-
Cargo Through	19/- to 22 6

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Strikes.

THE already complicated situation of the metallurgical and engineering trades has been rendered still more precarious this week by the strike of colliers organised by the Communist Federation, and although the strike is by no means general, the partial cessation of work in all the colliery districts, coinciding with the miners' strike in the Saar, threatens to make the early future, as regards fuel supplies, somewhat embarrassing. Very little coal is coming from the Ruhr and practically no coke, and, under the circumstances, the present communist agitation would be regarded as serious if it were not for the resistance offered by the great majority of men who have refused to put down tools. This does not affect the iron and steel trades to the extent it undoubtedly would in normal times. The iron and steel makers can do very little when they are unable to procure raw material, and during the past week practically nothing has been exported, while appreciable quantities of rolled iron have had to be imported from England. English coke is also being purchased at high prices, and the ability to procure such coke is brought forward by customers as an argument to contest the claims of blast-furnace proprietors and founders to cancel contracts, for it is urged that so long as coke can be obtained, at whatever cost, the contracts must be executed.

The Naval Programme.

The putting on the stocks this year of three light cruisers and a certain number of destroyers, torpedo boats and submarines represents the first part of a programme of naval construction which has been approved of by the Government and will be presented shortly to the Chamber of Deputies. The programme provides for the reconstitution of the fleet during a period of twenty years, the tonnage of battleships being that fixed by the Washington Conference; while the tonnage of light vessels will be what the French delegates themselves proposed, that is to say, 360,000 tons of surface craft, 65,000 tons of submarines, and 60,000 tons of seaplane carriers. During the first eight years no battleship will be put upon the stocks, and the new constructions will consist of six fast cruisers, fifteen destroyers, twenty-four torpedo boats, and thirty-four submarines. The expenditure in this period of eight years is estimated at 2400 million francs. The idea of the programme is to ensure, first of all, an effective air and submarine defence, with destroyers and fast cruisers for keeping open the route between France and North Africa, and any future battleship design will depend upon developments that take place in the meantime. The limited character of the programme is far from meeting with general approval, and is criticised on the ground that sufficient importance is not given to the construction of underwater craft.

Continuous Brakes.

The decision of the Superior Railway Council to recommend the Government to adopt the Westinghouse system of continuous brake for goods trains has aroused very strong opposition from those interested in the Lipkowski and Clayton-Hardy brakes on the ground that the report presented to the Superior Railway Council did not attach sufficient importance to the technical results of the trials. It is claimed that both the Lipkowski and Clayton-Hardy showed a great advantage in the time occupied in bringing the trains to rest, while there was also a considerable saving in the time required to couple up a train. The protests of the two rival companies were transmitted by the Minister of Public Works to the Superior Railway Council, which has issued a further statement to the effect that nothing has been brought forward to justify a reversal of the decision already come to, and the Council points out that the decision was based largely upon a question of economy, since the cost of adopting the Westinghouse would be far less than in the case of the Clayton-Hardy vacuum brake, while the Lipkowski is rejected on the ground that, having had no practical application, its employment would only be justified in the event of its showing a great superiority over the other systems. Nevertheless, the Council does not prohibit the employment of rival systems on condition of their being interchangeable with the Westinghouse, and the railway companies can, therefore, carry out any trials they please with continuous brakes on condition that they fulfil the requirements mentioned in the report.

Alcohol Fuel.

The Bill which has passed through the Chamber of Deputies requiring importers of petrol and other motor spirit to purchase from the State a quantity of alcohol equal to 10 per cent. of their importations, is based upon the understanding that the alcohol is to be mixed with the mineral spirit in the proportion stated. It is now urged that this method is scarcely operative, for the reason that petrol must be used for aviation engines, and that the cost of the mixture would be higher than petrol, so that if the mixture were sold at the same price as petrol the alcohol would have to be supplied by the State at below cost price, so that the difference would fall upon the taxpayer. Again, it is remarked that the 10 per cent. mixture does not give such satisfactory results as the 40 to 50 per cent. mixture, which is now nearly always employed. Experiments are also being made with the mixing of alcohol and petrol in the carburetter, whereby the necessity of dehydrating alcohol is dispensed with and the cost is largely reduced; but this utilisation of the combined fuel will not allow of a standard mixture, which is regarded as necessary, and the latest report upon the subject is to the effect that there should be a standard mixture of 40 to 50 per cent. alcohol; that is to say, importers would utilise their supply of alcohol in the preparation of this combined fuel, and would be permitted to sell the surplus petrol without restriction. Under the clause of the Bill the State will be able to impose mixtures according to the results obtained by the tests carried out by the official commissions.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

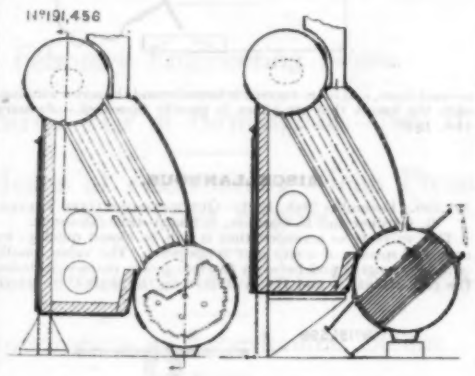
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

191,456. October 11th, 1921.—IMPROVEMENTS RELATING TO STEAM GENERATORS, Scott's Shipbuilding and Engineering Company, Limited, Greenock, and A. Rennie, 42, Robertson-street, Greenock.

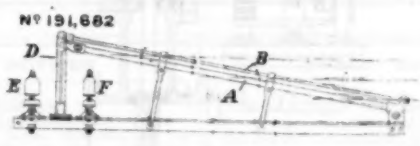
This boiler is intended to utilise the waste heat in the exhaust gases of internal combustion engines and at the same time be



adaptable for separate firing. It is of the water-tube type with a normal combustion space. In the water drum there is arranged a set of tubes, through which the exhaust gases are passed. The illustrations show alternative arrangements for the tubes.—*January 11th*, 1923.

191,682. June 29th, 1922.—HIGH AND LOW WATER ALARMS, Babcock and Wilcox, Limited, Oriel House, Farringdon-street, London, E.C. 4; and P. W. McGuire, 223, Green-lanes, London, N. 4.

This alarm is actuated by the expansion and contraction of the inclined tube A, which is in communication with the interior of the boiler. When the water level falls the tube becomes heated by

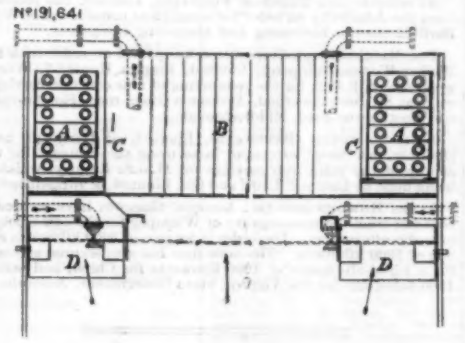


the steam within and expands longitudinally. The tie rod B is, however, unaltered. The lever D is thus moved to the left and operates the whistle E, which is of appropriately low tone. If high water makes the tube contract and the high-toned whistle F is blown.—*January 18th*, 1922.

CONDENSERS AND FEED-WATER HEATERS.

191,641. February 23rd, 1922.—A FEED WATER AND AIR HEATER, E. Green and Son, Limited, Wakefield, and G. E. Tansley.

The inventors propose to arrange an economiser and air heater on the top of a boiler. The economiser is divided into two similar sections A A on either side of the air heater B, from which

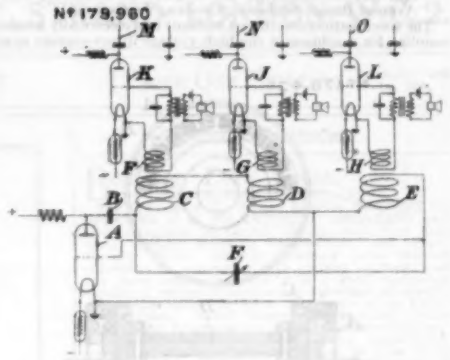


they are separated by plate walls C C. Dampers D D are provided so that the products of combustion may be diverted from the economiser sections when little feed water is being passed through them.—*January 18th*, 1923.

TELEGRAPHS AND TELEPHONES.

170,900. May 14th, 1921.—IMPROVEMENTS IN WIRED WIRELESS TELEPHONE SYSTEMS, Gesellschaft für Rrahtlose Telegraphie, m.b.H., of 9, Tempelhofer Ufer, Berlin, Germany.

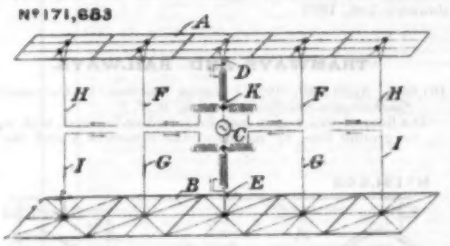
According to the scheme described in this specification, a single high-frequency generator is employed to supply high-frequency currents to a number of lines. In the anode circuit of a valve generator A a condenser B and three inductances C, D and E are placed, all being shunted by an adjustable condenser F, by means of which the circuit can be tuned so that the oscillations may be of the desired frequency. The coils C, D and E are coupled to coils F, G and H in the grid circuits of the valves K, J and L, and to these grid circuits the speech currents are applied. The high-frequency oscillations modulated by the speech currents are amplified by the valves K, J and L and are led to the telephone lines M, N and O. The coupling between the pairs of coils C, F, &c., should be sufficiently loose to prevent back action occurring. The invention offers the advantage that the waves in all the lines connected to the single generating system



are of the same length, so that no interfering notes can occur, as may happen if the lines are supplied by separate generators.—*January 18th*, 1922.

171,683. November 4th, 1921.—IMPROVEMENTS IN WIRELESS TRANSMITTING SYSTEMS, Peder Oluf Pedersen, of 1, Amalievej, Frederiksberg, near Copenhagen, Denmark.

The object of the transmitting arrangement described in this specification is to reduce the losses due to earth currents, or in other words to reduce the apparent resistance of the aerial. In the diagram A is the aerial and B an earth screen. The generator C



is connected by pairs of conductors D E, F G, and H I to the aerial and screen as shown, whilst inductances K are inserted between the generator and these conductors so that the currents are of the same phase at all the points where the conductors are connected to the aerial and also at all the points where the conductors are connected to the earth screen.—*January 18th*, 1923.

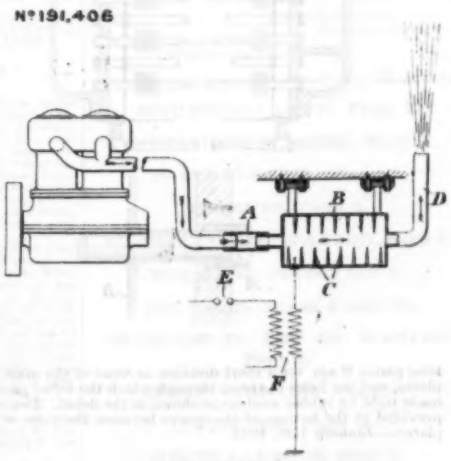
190,404. August 10th, 1917.—IMPROVEMENTS IN COHERERS FOR DETECTING ELECTRIC RADIATION, Archibald Montgomery Low, of Royal Flying Corps Experimental Works, Feltham, Middlesex.

The object of this invention is to increase the sensitiveness and improve the operation of coherers. Metallic filings or particles comprising a mixture of silver and nickel filings are coated wholly or in part with the sulphides of the respective

metals by heating the particles in a stream of or in an atmosphere of sulphur dioxide. These particles or filings may be employed in any form of coherer, a suitable construction being shown. The particles A are enclosed in a glass or other tube B, C and D being electrodes. The electrode C is fixed and the electrode D adjustable.—*February 8th*, 1923.

191,406. January 9th, 1918.—IMPROVEMENTS IN WIRELESS TELEGRAPHIC APPARATUS, Archibald Montgomery Low, of the Experimental Works, Feltham, Middlesex.

This invention relates mainly to wireless telegraphic apparatus for use upon aircraft or upon motor or other vehicles used on the front line trenches or, in general, in any situation where it is impossible or inconvenient to provide any of the ordinary forms of aerial. The exhaust pipe of an engine is connected by an



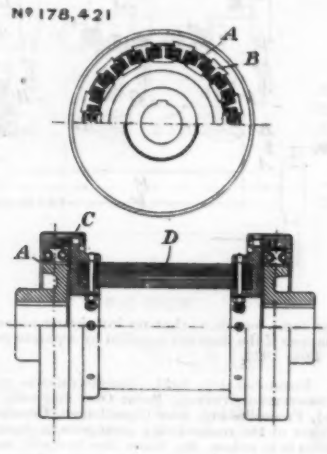
insulating sleeve A with a box or casing B which is also insulated. The interior of the box is provided with spikes, and it has been found that the exhaust gases issuing from the pipe D form an efficient aerial. The aerial may, of course, be included in any desired circuit comprising, for example, a spark gap E and an induction coil F.—*February 8th*, 1923.

DYNAMOS AND MOTORS.

178,421. April 15th, 1922.—IMPROVEMENTS IN COUPLINGS FOR MACHINES OF THE HIGH-VOLTAGE DIRECT-CURRENT SERIES SYSTEM, Charles Joseph Belli, of the Swiss Confederation; and Société Anonyme des Ateliers de Secheron, both of Avenue Blanc, Secheron, Geneva, Switzerland.

The specification describes a resilient and electrically insulating coupling for machines of the high-voltage direct-current system.

Nº 178,421



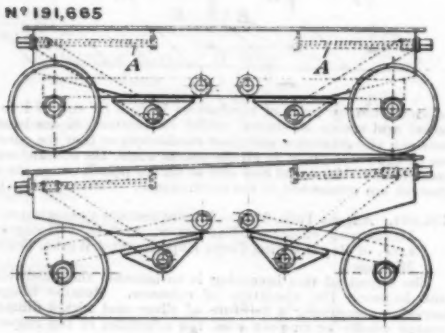
Springs inserted between the teeth A serve for transmitting the torque to the teeth B inside the metal rim C, and the two couplings are connected together by an insulating tube D.—*January 10th*, 1923.

TRAMWAYS AND RAILWAYS.

191,665. April 20th, 1922.—GOODS WAGONS. *W. Carpmael, 24, Southampton-buildings, London, W.C. 2.*

The floor of this wagon may be raised or lowered, with regard to the ground line, by means of the screws A A and the link

Nº 191,665



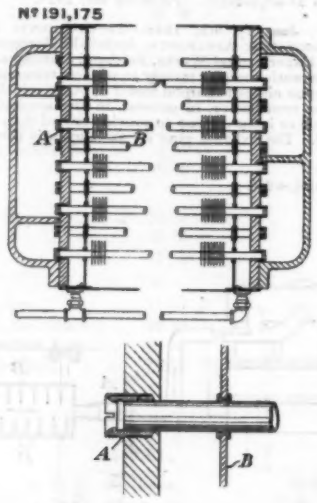
work shown. The arrangement has the advantage that the whole of the raising mechanism is always below the wagon floor.—*January 18th*, 1923.

LIGHTING AND HEATING.

191,175. October 11th, 1921.—AIR HEATERS, Heenan and Froude, Limited, Worcester, and G. H. Walker.

This heater is of the type in which water is circulated through the tubes and air round the outside of them. In order to prevent any likelihood of water, which may leak through the joints A in the tube plate, from coming into contact with the air, additional

Nº 191,175



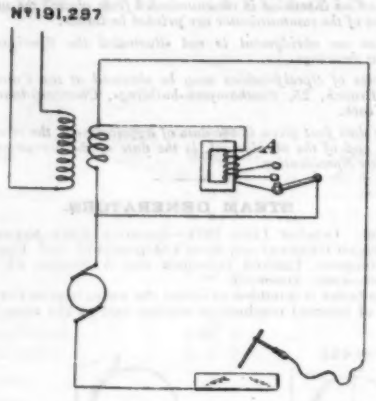
tube plates B are set a short distance in front of the main tube plates, and the holes in them, through which the tubes pass, are made tight by rubber washers as shown in the detail. Drains are provided at the bottom of the spaces between the pairs of tube plates.—*January 11th*, 1923.

WELDING.

191,297. January 31st, 1922.—IMPROVEMENTS IN OR RELATING TO DYNAMO-ELECTRIC GENERATORS, Walter Leonard Lorkin, Ernest Edgar Daglish, and Henry Bevan Swift, all of 2 and 3, Norfolk-street, W.C. 2.

The arc welding electric generator described in this specification has an inductance A arranged as a shunt to a differential series winding. When a sudden increase of current takes place, as, for instance, when the electrode touches the work, the shunt, owing to its high inductance, takes much less current than its

Nº 191,297



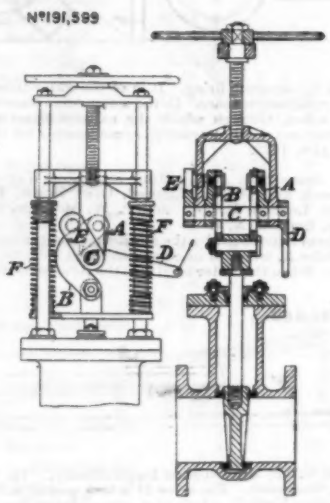
normal share, and more current is forced round the series winding, with the result that its effect is greatly increased.—*January 11th*, 1923.

MISCELLANEOUS.

191,599. December 28th, 1921.—QUICK-CLOSING GATE VALVES, R. Gardner and E. Gardner, 5, Sharp-street, Gourock.

This valve is so arranged that it will be closed quickly, by means of springs, if a trip gear is operated. The valve spindle is in two lengths and between the two pieces there is included the pair of links A and B. A is fixed on the shaft C, to which

Nº 191,599



the trip lever D is also keyed. Another arm E is also keyed to C, and when in the position shown, a stop on its end, by bearing against the frame, locks the links in that position. If the trip lever is raised so that the link A is moved beyond the dead centre, the springs F close the valve.—*January 18th*, 1923.

CONTRACTS.

AUTOMATIC AND ELECTRIC FURNACES, Limited, has received from the Admiralty an order for a complete installation of Wild-Barfield electric hardening and tempering equipment.

THE Middlesbrough Corporation has placed an order with the Walker-Weston Company, Limited, Empire House, 7, Wormwood-street, E.C. 2, for the reinforcing of four concrete carriageways at St. Barnabas-road, Ayresome Green-road, Roman-road, and Eastbourne-road, Middlesbrough.

JOHN COCHRANE (BARRHEAD), Limited, of Barrhead, near Glasgow, has been successful in securing the contract for the supply of the main iron castings for H.M.S. Rodney, which is being built by Cammell Laird and Co., Limited, of Birkenhead.

JAMES HOWDEN AND CO., Limited, Glasgow, have secured a contract from the municipality of Winnipeg for the construction of turbo-alternators. The order is for two of 5000 kilowatts and one of 1000 kilowatts. The same firm has also secured an order for a turbo-alternator of 1000 kilowatts for China, and one of 1500 kilowatts for the Victoria State Government, Australia.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

E. J. SILCOCK, M. Inst. C.E., F.S.I., F.G.S., asks us to state that he has removed his London office from 17, Victoria-street, to 25, Victoria-street, Westminster.

WE are asked by Messrs. A. G. Cloake, of 54, Holborn Viaduct, to say that the difficult position in which the French pipe founders are placed to-day owing to the scarcity of coke has been exaggerated, and that La Société Metallurgique d'Aubrives et Villerupt reports that it has not yet experienced any trouble that might decrease its output of pipes.

A JOINT Town Planning Committee consisting of representatives of local authorities situated within the Thames Valley has been set up for the purpose of co-ordinating the development of the several districts which together form this important sector of the metropolitan area. The Committee has appointed Messrs. Thomas Adams and Longstreth Thompson to prepare an outline scheme of development for the whole region. This firm is also acting in a like capacity for the West Middlesex Joint Town Planning Committee.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF PRODUCTION ENGINEERS.—The Engineers' Club, Coventry-street, W. 1. Paper, "Machine Moulding Methods" (slides), by Mr. T. F. Hardyman. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette, "Characteristics, Operation and Maintenance of Underground Cables," by Mr. A. J. Tracey. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "The Interior of a Star," by Professor A. S. Eddington. 9 p.m.

SATURDAY, FEBRUARY 24TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Visit of the London Graduates to the works of Sparklets, Limited, Upper Edmonton, N. 18; nearest station, Angel-road, G.E.R. Meet outside the works, 2.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Municipal Buildings, Earl-street, Crewe. North-Western District meeting. 11 a.m.

MONDAY, FEBRUARY 26TH.

BRADFORD ENGINEERING SOCIETY.—The Technical College, Bradford. Lecture, "Power Production in relation to Ultimate Values," by Mr. A. H. Seabrook. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' SECTION, LONDON.—Storey's-gate, S.W. 1. Annual lecture, "Photo-elastimetric Researches on Mechanical Engineering Problems," by Professor E. G. Coker. 7 p.m.

UNIVERSITY OF LONDON.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Lectures. I. "The Control of the Speed and Power Factor of Induction Motors." II., "Various Methods of Changing the Speed of Induction Motors, &c." 5.15 p.m.

TUESDAY, FEBRUARY 27TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: COVENTRY CENTRE.—Railway Hotel, Coventry. Paper, "High-speed Oil Engines," by Mr. J. L. Chaloner. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Continued discussion on:—"Colombo Drainage Works," by Mr. R. E. Tickell; "Evolution in Sewage Disposal, with Special Regard to South African Experience in Sludge Treatment, Particularly at Pretoria," by Mr. F. W. Jameson; and "Main Drainage of the Southern Suburbs of the City of Cape Town, South Africa," by Mr. D. E. Lloyd-Davies. 6 p.m.

INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Philosophical Hall, Leeds. Lecture, "Engineering Factory Organisation," by Sir Henry Fowler. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—Queen's Hotel, Leeds. Address by Mr. F. Gill, President of the Institution. 7.15 p.m.

NATIONAL ASSOCIATION OF SUPERVISING ELECTRICIANS AND ASSOCIATION OF ENGINEERS-IN-CHARGE.—St. Bride's Institute, Bride-lane, E.C. 4. Joint lecture, "Preparation of Estimates, Specifications and Contracts for Electrical Work," by Messrs. W. E. Highfield and A. Kirk and Captain A. E. Penn. 7 p.m.

INSTITUTE OF MARINE ENGINEERS, 85–88, The Minories, Tower Hill, E. 1. "Auxiliary Machinery," by Engineer-Commander R. Beeman. 6.30 p.m.

WEDNESDAY, FEBRUARY 28TH.

ENGINEERING GOLFING SOCIETY.—Institution of Civil Engineers, Great George-street, S.W. 1. Annual general meeting. 12 a.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Visit of the Birmingham Graduates to the works of Serck Radiators, Limited, Warwick-road, Greet. 2.45 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—Education Offices, Salford. Paper, "High-speed Oil Engines," by Mr. J. L. Chaloner. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Students' meeting. Lecture, "Recent Developments in Wireless Telephony," by Captain H. Riall Sankey. 6 p.m.

INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Royal Victoria Station Hotel, Sheffield. Lecture, "Engineering Factory Organisation," by Sir Henry Fowler. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Heat-resisting Glasses," by Professor W. E. S. Turner. 8 p.m.

THURSDAY, MARCH 1ST.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. "Permissible Loading of British Standard Paper-insulated Electric Cables," by Messrs. S. W. Melsom and E. Fawsett. British Electrical Research Association Report. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Water Power of the Empire," by Mr. T. Stevens. 3 p.m.

FRIDAY, MARCH 2ND.

INSTITUTE OF MARINE ENGINEERS.—Hotel Victoria, S.W. Annual conversazione. 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette, "Glass-forming Machines," by Mr. C. Saxton. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "The Water in the Atmosphere," by Dr. G. C. Simpson. 9 p.m.

SATURDAY, MARCH 3RD.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Atomic Projectiles and their Properties. III.," by Sir Ernest Rutherford. 3 p.m.

WEDNESDAY AND THURSDAY, MARCH 7TH AND 8TH.

INSTITUTE OF METALS.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Annual general meeting, 10 a.m. to 5 p.m. on each day. Annual dinner, Trocadero Restaurant, Piccadilly-circus, W. 1, on Wednesday, 7th, 7 p.m. for 7.30 p.m.

For programme see page 183.